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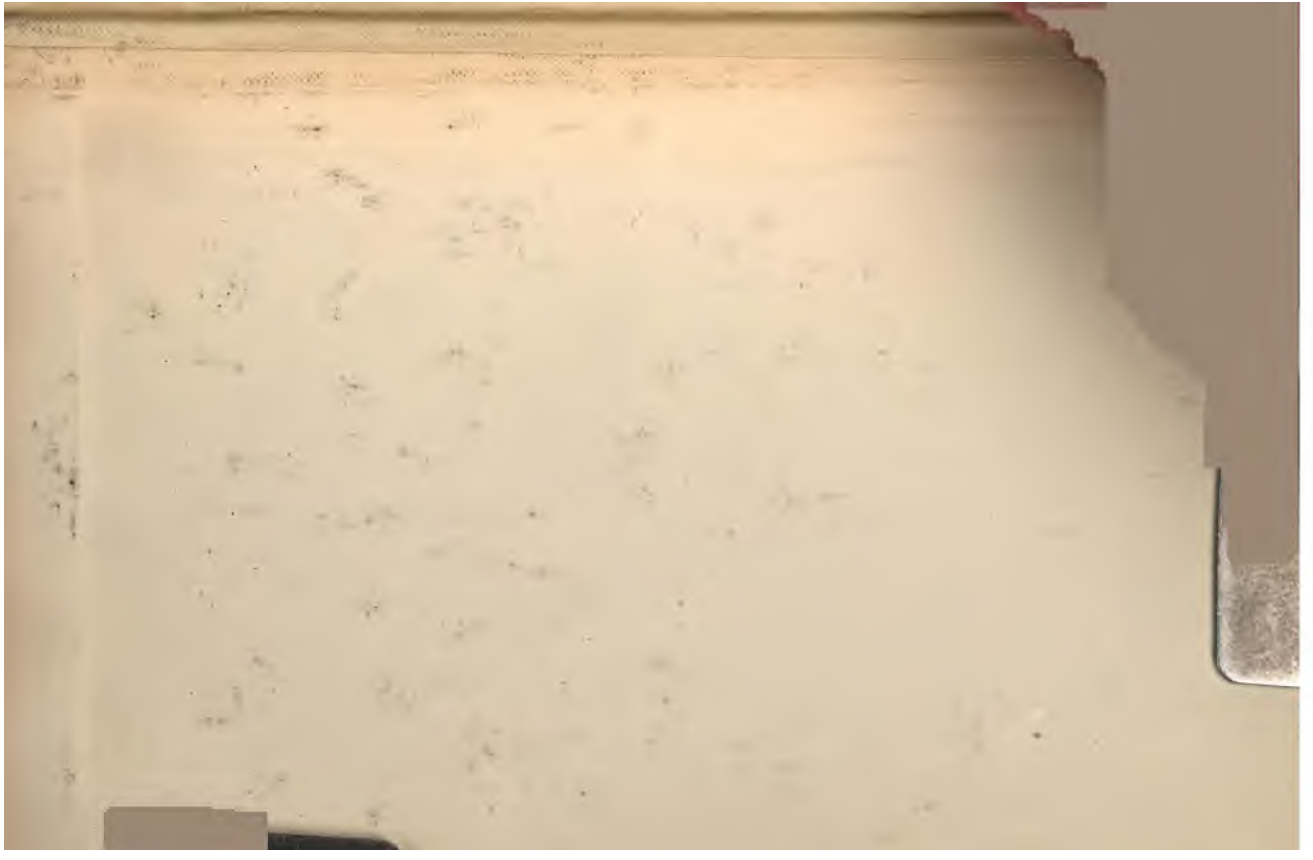

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Underhill

MINERAL LAND SURVEYING

BY

JAMES UNDERHILL, PH. D.

MINING ENGINEER

U. S. Mineral Surveyor for Colorado

THIRD EDITION REVISED

NEW YORK

JOHN WILEY & SONS, INC.

LONDON: CHAPMAN & HALL, LIMITED

1922

41176A

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PREFACE TO THE THIRD EDITION

In this edition several additions have been made, especially in the treatment of the direct solar observation. The specimen field notes, to illustrate the requirements of the office of the United States Surveyor General for Colorado, have been entirely rewritten, a different group of claims being used, and represent the practice at the present time. Thanks are due Mr. F. E. France of the office of the United States Surveyor General for valuable help and suggestions in making up the notes.

PREFACE TO FIRST EDITION

In the work which follows an attempt has been made to describe the methods used at the present time in the survey of mineral lands in the western portion of the United States. Only as much of general surveying has been given as is necessary to a clear understanding of the subject, and the reader is referred to the various text books on surveying for all information of a general nature. The reader is also referred to Morrison's "Mining Rights" for the treatment of the purely legal points.

It will be impossible to give credit to all those who have assisted the writer, either during the period when the work was appearing as a serial in *Mining Reporter*, or in its final incorporation in book form. To all those who have assisted, the writer wishes to express his heartfelt thanks, and especially to Professors L. E. Young, E. M., and A. J. Hoskin, Mech. E. of the Colorado School of Mines; Professor Mark Ehle, E. M., of the South Dakota School of Mines; N. H. Brown, E. M., U. S. Mineral Surveyor, formerly Chief of the Mineral Division, and M. E. Blake, the present Chief of the Mineral Division, Office U. S. Surveyor General for Colorado. The writer is also indebted to H. G. Moulton, E. M., and P. P. Barbour, E. M., U. S. Mineral Surveyors, for many valuable suggestions, and to William Hyland for assistance in the calculations.

Thanks are due Wm. Ainsworth & Sons, and W. & L. E. Gurley for permission to use cuts and descriptive matter concerning the Shattuck and Burt Solars.

The writer, in conclusion, cannot acknowledge too strongly the assistance of his wife, which has been invaluable to him.

TABLE OF CONTENTS

CHAPTER I

DIRECT SOLAR OBSERVATIONS

Placing the Sun — Derivation of Formula — Examples of Observations and Figuring — Latitude Observations — Errors in Observations of Latitude 1–24

CHAPTER II

SOLAR ATTACHMENTS

The Shattuck Solar — The Burt Solar — The Berger and Saegmuller Solars..... 25–51

CHAPTER III

MEASUREMENTS

Traversing — Measuring — Stations — Slope Measurements — Obstacles — Closing Lines in Traversing — Rule for Azimuth 52–64

CHAPTER IV

LOCATION SURVEYS

Lode Locations — Note Book — Location Certificates — Angular Claims — Relocation and Amended Location — Mill Sites and Placers — Double Meridian Distances — Tunnel Sites — Legal Subdivisions — Tracing Vein Extensions..... 65–103

CHAPTER V

PATENT SURVEYS

Surveying for Patent — Angles from Courses — Patent Figuring — Area Statement — Miscellaneous on Patents — Adverses and Protests..... 104–144

CHAPTER VI

PATENT FIELD NOTES

Patent Field Notes..... 145–163

CHAPTER VII

LAND OFFICE AND RECORDS

Office United States Surveyor General — Land Office Regulations — Public and Private Records 164-186

CHAPTER VIII

EXAMINATION FOR COMMISSION UNITED STATES MINERAL SURVEYOR

Placer Calculations — Lode Line Calculation — Subdivision of Section — Examination Questions, South Dakota, California, Oregon — The Patenting of Mineral Lands..... 187-213

APPENDIX

Instructions to United States Mineral Surveyors..... 214–233

Mineral Land Surveying

CHAPTER I

DIRECT SOLAR OBSERVATION

Of the applications of plane surveying to the survey of mineral lands, no one is more representative or has been more greatly perfected in the West than the use of the sun to determine the bearing of a given line. For many years bearings were determined by the use of various solar attachments, but of late years the method known as the direct observation seems to have almost entirely taken their place. While with great care any one of the several solar attachments on the market will give fair or even good results, they are all relatively expensive, fragile and, with one exception, easily thrown out of adjustment. With the method known as the direct observation, no attachment is needed to the ordinary transit provided with a vertical arc or circle, preferably the latter, and no adjustment has to be considered other than those necessary to use in every transit in mineral land surveying.

As the exact determination of the bearings of lines is probably more important in mineral land surveying than in any other branch of engineering, disregarding of course geodetic work, it will be taken up in detail.

To determine the bearing of a line by direct observation, the transit is set up as solidly as possible and carefully leveled. The line whose bearing is to be determined may be considered o° and the upper plate set at o°, or if the

bearing is approximately known. The upper plate may be set at the assumed bearing and afterwards corrected. If more convenient, the assumed bearing of a line to some prominent object may be taken, and the first course required on the survey reflected from this line. The upper plate is then loosened and the telescope pointed at the sun. The sun may be observed in various ways; for example, through a colored glass placed over the eye-piece, to which may be added a prism when the sun is very high. This colored glass may be very conveniently placed in the sliding cover of the eye-piece and is thus always ready for use. As this method involves the attachment of the colored glass, and also, when the sun is high, some personal discomfort as regards the position of the head, it is advisable to use a card, a sheet of paper, or, best of all, the brown back of a note-book, which does away with the glare on a white surface. On this surface, preferably held by the assistant, the cross wires are first focused, and finally the sun is brought into the proper position, by the aid of the tangent screws.

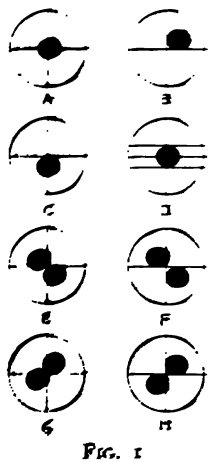


FIG. 1

A Davis screen is a piece of apparatus attached to the telescope to answer the same purpose as the card mentioned above, and its use leaves both hands free to manipulate the instrument. Otherwise it is of no great advantage.

In regard to placing the sun with reference to cross wires, there are many opinions. In most treatises we are cautioned not to bisect the sun, as in Fig. 1*A*, but to place

it in one quadrant, as in Fig. 1*B*, as it can thus be observed more accurately. While this is perfectly sound advice, especially with inverting instruments, a correction for semi-diameter of the sun must be made, and the operation is liable to be somewhat confusing to the beginner. The student is therefore advised at first to divide the sun into quadrants by the two cross hairs (Fig. 1*A*) leaving the method of placing the cross hairs tangent until proficiency is secured. As an error of one minute in placing the vertical cross wire causes an error of one minute in the resulting azimuth, while an error of one minute in placing the horizontal wire causes an error of several minutes in the result, it might be well to place the sun as in Fig. 1*C*. The reason for this will readily be seen on examining the examples which follow. The sun, in very accurate work, is sometimes placed in a rectangle or other arrangement of cross wires, but in ordinary work these are unnecessary refinements.

Another very exact method of observing the sun in the direct observation is to place the sun tangent to the cross wires, first in the N. W. corner with the telescope normal, then in the S. E. corner with the telescope inverted. The sun is held tangent to one wire with the tangent screw and the observation is made when the sun, by its own motion, reaches the other wire. In Fig. 1, *E* and *F*, are shown the positions of the sun for normal and inverted telescope just before and at the instant of observation. These are the best positions for an observation taken in the morning. In the afternoon the positions are reversed. (Fig. 1, *G* and *H*.)

The average of the two vertical and two horizontal angles are used in each case in the subsequent calculation *and in this way all* consideration of the semi-diameter

the sun is avoided. At least two sets of such observations must be made, otherwise there is no check.

In an instrument provided with stadia wires, care must be taken not to confuse these with the horizontal cross wire. Moreover it is not well to assume, without a trial, that the stadia wires are equally distant from the horizontal cross wire.

If the stadia wires are correctly placed they should be 0° 34′ 22″ apart, and each 0° 17′ 11″ from the center horizontal wire. As the sun's semi-diameter varies around 0° 16′ the stadia wires may be used with advantage to place the sun with a very slight probable error. (Fig. 1*D*.)

We will assume that the sun has been bisected. The vertical and horizontal circles are then read and noted and an observation made with the telescope inverted, assuming that the first observation was made with the telescope normal. The bearing of the sun should be taken with the magnetic needle at least once during the observation, as a check on the results. The time to the nearest fifteen minutes should be taken when the telescope is inverted. By averaging the two results all errors of adjustment or in leveling the instrument are obviated. As a check, a number of observations may be made on the sun, and the writer finds that three or four with normal telescope and the same number with inverted telescope are sufficient. The observations should not be made within two hours before or after noon, nor when the sun is too near the horizon, as the correction for refraction is then too great.

The direct solar observation depends on the solution of a spherical triangle (see Fig. 2) whose sides are all known, and whose angle between two planes is desired. These planes, as can be seen from the figure, are one, observer, zenith, pole; and the other, observer, zenith, sun. In

our work we have first the latitude, distance pole to horizon or zenith to equator, and therefore the co-latitude (90° — latitude) for one side; or, in other words, we have from pole to zenith; we have the declination, distance of

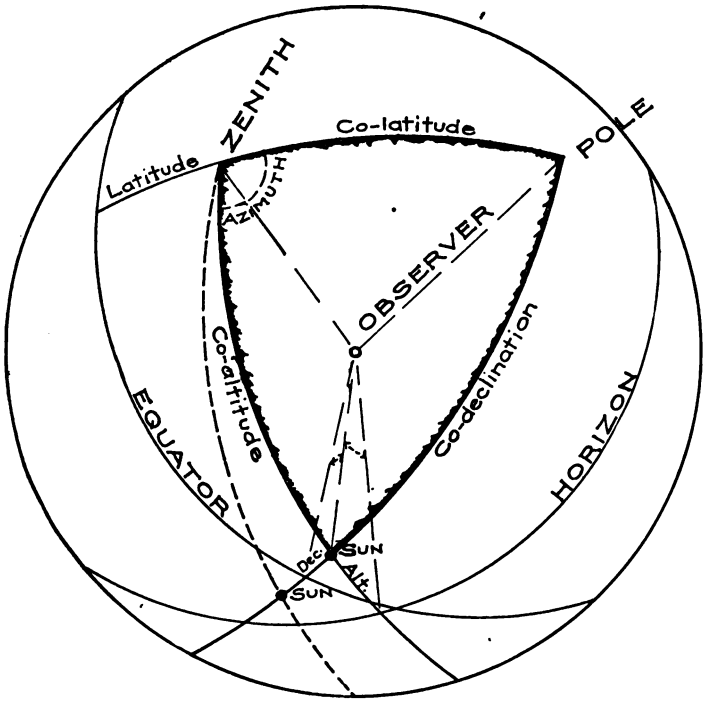


FIG. 2

the sun above or below the equator and therefore the co-declination (90° — declination), that is from pole to sun, and we finally get the altitude and thence the co-altitude (90° — altitude) by the solar observation with the transit as described above. In Fig. 2 the sun is shown by solid lines north of the *equator* and by dotted lines south of the

equator. This also shows its position before noon. This triangle may be solved by any one of the various formulas found in every treatise on spherical trigonometry.

The best formula, however, for the direct observation is that derived by John G. McElroy, and given in the *Michigan Engineer's Annual* for 1899, page 62, as follows:

$$\text{"Cos } Z = \pm \frac{\sin d}{\cos l \cos a} \mp \tan l \tan a,$$

which is simply a modification of one of the fundamental equations of spherical trigonometry.

Before illustrating the utility of the formula and the facility with which it may be logarithmically reduced, it will be proper, for the sake of completeness, to give the argument on which it rests. To this end let *PZS*, Fig. 3,

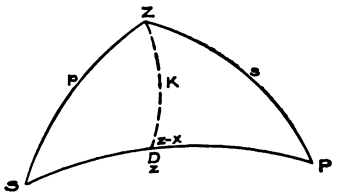


FIG. 3

be a spherical triangle, and K an arc of a great circle drawn from Z perpendicular to PS, (or to PS produced).

Then from the triangle PZD,

$$\cos s = \cos k \cos (z - x), \tag{1}$$

and from the triangle SZD,

$$\cos p = \cos k \cos x. \tag{2}$$

Eliminating $\cos k$, we find

$$\frac{\cos s}{\cos p} = \frac{\cos (z - x)}{\cos x} = \cos z + \sin z \tan x. \tag{3}$$

But, from SZD, $\cos S = \tan x \cot p$;

whence, $$\tan x = \frac{\sin p}{\cos p} \cos S. \qquad (4)$$

Placing this in (3) there results

$$\frac{\cos s}{\cos p} = \cos z + \frac{\sin p \sin z}{\cos p} \cos S;$$

or, $$\cos s = \cos p \cos z + \sin p \sin z \cos S. \qquad (5)$$

This is the above-mentioned 'fundamental equation.' It asserts that the **cosine of either side of a spherical triangle equals the product of the cosines of the other sides, plus the product of the sines of those sides into the cosine of their included angle.** To apply it to the derivation of our solar formula, let us consider Fig. 4, which represents the four astronomical triangles, PZS, PZS', $P'Z'S$, and $P'Z'S'$, projected on the plane of the meridian $PNHZ$. In A.M. observations, the azimuth angles at Z or Z' will be estimated from the north to the right; in P.M. observations, from the north to the left.

We adopt the following notation:

PP' = axis of the celestial sphere.
P = the celestial north pole.
P' = the celestial south pole.
EQ = the celestial equator.

HO = the celestial horizon of which the poles are Z and N. (Note. — The horizon of which Z' and N' are the poles is not shown in the figure; it would be projected as a diameter perpendicular to $Z'N'$.)

Z and N = zenith and nadir of an observer in north latitude. Z' and N' = zenith and nadir of an observer in south latitude.

$EZ = l$ = observer's latitude when at Z.
$EZ' = l$ = observer's latitude when at Z'.
S = the sun when north of the equator.
S' = the sun when south of the equator.
$VS = d$ = the sun's declination when north.
$VS' = d$ = the sun's declination when south.
PS = the sun's north polar distance when north.
PS' = the sun's north polar distance when south.
$MS = a$ = the sun's altitude when north.
$M'S' = a$ = the sun's altitude when south.
pp' = the sun's daily path when north.
p_1p_2 = the sun's daily path when south.

It will be sufficient to consider the particular case of an observer in north latitude, and the sun in north declination (whence d and l are positive; a is always positive), and then make our results general by properly observing the signs of d and l.

The case assumed is illustrated by the triangle PZS (Fig. 4), in which —

$$PS = 90° - VS = 90° - d,$$
$$PZ = 90° - EZ = 90° - l,$$
$$SZ = 90° - MS = 90° - a,$$

and the sun's azimuth angle PZS is required. It is found thus: By applying the principle of which equation (5) is the enunciation to the angle PZS, we have —

$$\cos PS = \cos PZ. \cos SZ + \sin PZ. \sin SZ. \cos Z;$$

$$\text{or, } \cos (90° - d) = \cos (90° - l) \cos (90° - a) + \sin (90° - l) \sin (90° - a) \cos Z,$$

$$\text{whence, } \sin d = \sin l \sin a + \cos l \cos a \cos Z.$$

$$\text{From this, } \cos Z = \frac{\sin d}{\cos l \cos a} - \tan l \tan a. \qquad (6)$$

In (6) cos l, cos a, and tan a are always positive, but sin d and tan l will respectively have the signs of d and l;

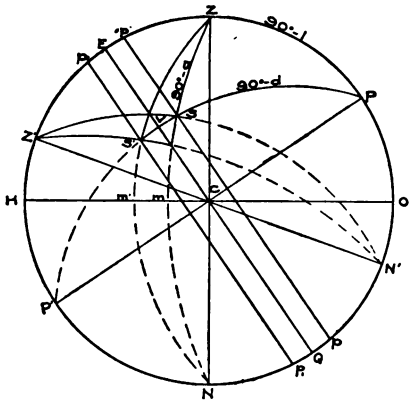


FIG. 4

hence to prevent mistakes it is advisable to write the expression in the form

$$\cos Z = \pm \frac{\sin d}{\cos l \cos a} \mp \tan l \tan a, \qquad (7)$$

which is the desired solar formula.

With respect to the signs of the formula, the surveyor has simply to remember that the first term of the second member is

\+ for north declinations,
− for south declinations,

and that the second term is

− for north latitudes,
\+ for south latitudes.

For north latitudes the formula always gives negative values for cos Z when the declination is south, and also for such *north declinations* and values of a as render sin

d less than $\sin l \sin a$;* but when cos Z is negative, Z is greater than 90°, and hence the positive value of the cosine, as taken from the table of 'Naturals' is the cosine of $(180° - Z)$, (i.e., of EZS, the azimuth from the south) for $-\cos Z = \cos (180° - Z)$."

This means that in the case of observations taken near the summer solstice one may get the sun north of east or north of west when one is observing near sunrise or sundown. Care must be taken, therefore, not to set this down as a south course merely because the sun is south of east or west during the greater part of the year. This will be taken up later under the calculations for the direct observation.

As an example we will take the following series of direct observations on the sun, the first two with telescope normal, and the last two with telescope inverted:

Angle to right from line to be determined.	Altitude of sun.
233° 16′ (See Fig. 5.)	52° 51′
233 33	53 03
234 01	53 18
234 17	53 29

Difference for 1 hour = 29.45
5.0
60)147.25
Difference for 5 hours = 2′ 27″

July 22, 1905, 10 A.M., latitude 39° 47′ north.

Dec. Greenwich apparent noon....	20° 22′ 18.1″
Less 5 hours west.....	2 27.0
Call 20° 19′ 51″ = 20° 20′	20° 19′ 51.1″

* Or when the sun is south of the prime vertical.

$$\text{Cos azimuth} = \frac{\sin 20^\circ\ 20'}{\cos 39^\circ\ 47'.\ \cos 52^\circ\ 50^*\ \text{etc.}} - \tan 39^\circ\ 47' \tan 52^\circ\ 50^*\ \text{etc.}$$

$$\begin{aligned} \log \sin 20^\circ\ 20' &= 9.540931 \\ \log \cos 39^\circ\ 47' &= 9.885627 \\ & \overline{\quad\quad} \\ & 9.655304 \end{aligned}$$

$$\begin{aligned} & 9.655304 \\ \log \cos 52^\circ\ 50' &= 9.781134 \\ & \overline{\quad\quad} \\ \log 0.7485 &= 9.874170 \end{aligned}$$

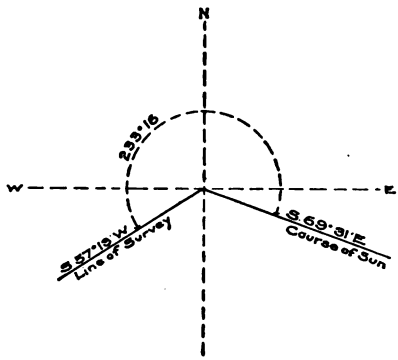


FIG. 5

$$\begin{aligned} \log \tan 39^\circ\ 47' &= 9.920476 \\ \log \tan 52^\circ\ 50' &= 10.120259 \\ & \overline{\quad\quad} \\ \log -1.0984 &= 0.040735 \\ +0.7485 & \\ & \overline{\quad\quad} \\ -0.3499 &= \text{nat. cos } 69^\circ\ 31' \text{ (course of sun)} \\ & \quad 233^\circ\ 16' \\ & \overline{\quad\quad\quad} \\ & 302^\circ\ 47' \end{aligned}$$

$$\begin{aligned} & 9.655304 \\ \log \cos 53^\circ\ 2' &= 9.779128 \\ & \overline{\quad\quad} \\ \log 0.7519 &= 9.876178 \end{aligned}$$

* *Corrected for* refraction — always diminished.

log tan 39° 47′ = 9.920476
log tan 53° 2′ = 10.123411

log −1.1066 = 0.043887
+0.7519

−0.3547 = nat. cos 69° 14′ (course of sun)
233° 33′

302° 47′

360° 00′
302° 47′

S. 57° 13′ W. (See Fig. 5.)

9.655304
log cos 53° 17′ = 9.776598

log 0.7564 = 9.878706

log tan 39° 47′ = 9.920476
log tan 53° 17′ = 10.127360

log −1.1163 = 0.047836
+0.7564

−0.3599 = nat cos 68° 54′
234° 01′

302° 55′

9.655304
log cos 53° 28′ = 9.774729

log 0.7596 = 9.880575

log tan 39° 47′ = 9.920476
log tan 53° 28′ = 10.130263

log −1.1239 = 0.050739
+0.7596

−0.3643 = nat. cos 68° 38′
234° 17′

302° 55′

13′		
13′		
05′	360° 00′	
05′	302° 55′	
4)36′	S. 57° 5′ W.	
9′		

Average course of line, S. 57° 9′ W.

When the observation is made with the sun north, as in the example given for July 22, we have the first term of the formula plus, north declination, and the second term minus, north latitude. The resulting cosine is minus.

$$\begin{array}{r} +\ .7485 \\ -\ 1.0984 \\ \hline -\ .3499 = \text{S. } 69^\circ\ 31'\ \text{W.} \end{array}$$

With the sun south on December 27 an observation gives us

$$\begin{array}{r} -\ .5452 \\ -\ .2919 \\ \hline -\ .8371 = \text{S. } 33^\circ\ 10'\ \text{E.} \end{array}$$

and the resulting cosine is also minus.

But when the sun is north and near the summer solstice and the observation is taken early or late in the day we get on June 30

$$\begin{array}{r} +\ .5664 \\ -\ .3905 \\ \hline +\ .1759 = \text{N. } 79^\circ\ 52'\ \text{E.} \end{array}$$

Therefore if the sign of the cosine is minus, the bearing of the sun is south of east or west, but if the sign is plus the bearing is north of east or west.

It will be seen that the cos and tan of the latitude and

altitude, respectively, are found on the same line in the tables and are set down at the same time for calculation.

The sun's semi-diameter varies from about 16′ 15″ on January 1 to 15′ 45″ on July 2, and is found in the Ephemeris. The average, 16′ nearly, will do for ordinary work.

If it becomes necessary to base calculations on an observation where the sun is observed in only one quadrant, a correction for semi-diameter must be made. The vertical angle is corrected by simply adding or subtracting the semi-diameter, as the sun is above or below the horizontal wire. The horizontal angle must be corrected by adding or subtracting the semi-diameter of the sun divided by the cosine of the altitude, as the right or left side of the sun is taken clockwise from the backsight.

TABLE OF CORRECTION

Corr. alt. sun's cen.	Sun's semi-diam. measured at horizon.	Corr. alt. sun's cen.	Sun's semi-diam. measured at horizon.
0° 00′	16′ 00″	35° 33′	40″
8 14	10	36 13	50
11 36	20	36 52	20′ 00
14 08	30	37 30	10
16 16	40	38 06	20
18 06	50	38 42	30
19 45	17 00	39 16	40
21 15	10	39 50	50
22 37	20	40 22	21 00
23 54	30	40 54	10
25 05	40	41 25	20
26 12	50	41 55	30
27 16	18 00	42 24	40
28 16	10	42 53	50
29 13	20	43 21	22 00
30 08	30	43 48	10
31 00	40	44 14	20
31 50	50	44 40	30
32 38	19 00	45 06	40
33 24	10	44 31	50
34 09	20	45 55	23 00
34 52	30	46 19	10

The refraction, always subtracted from the apparent altitude, is 57″ × tan zenith distance of sun or by table.

MEAN REFRACTION (TO BE SUBTRACTED FROM OBSERVED ALTITUDE)
BAROMETER 30 INCHES; THERMOMETER 50° FAHRENHEIT

Altitude.	Refraction.	Altitude.	Refraction.
10°	5′ 19″	20°	2′ 39″
11	4 51	25	2 04
12	4 27	30	1 41
13	4 07	35	1 23
14	3 49	40	1 09
15	3 34	45	58
16	3 20	50	49
17	3 08	60	34
18	2 57	70	21
19	2 48	80	10

The declination may be taken from the Ephemeris published by any instrument maker. At Denver we are seven hours later in apparent time than at Greenwich, one hour for each 15° of longitude, and this difference in time multiplied by the hourly difference given in the Ephemeris is added or subtracted, as the declination is increasing or decreasing, to or from the declination given for Greenwich noon.

As the greatest hourly difference in declination is about 1′ it is sufficiently exact to calculate the declination to the nearest fifteen minutes of time, or even to the nearest half hour, for the average hourly difference, which is 30′ of declination.

By inspection of the following table errors resulting from the use of erroneous data for declination or latitude may be found.

ERRORS IN AZIMUTH FOR 1 MINUTE ERROR IN DECLINATION OR LATITUDE

No. of hours from noon.	For 1 minute error in declination.			For 1 minute error in latitude.		
	Lat. 30°	Lat. 40°	Lat. 50°	Lat. 30°	Lat. 40°	Lat. 50°
h. m.	Min.	Min.	Min.	Min.	Min.	Min.
0 30	8.85	10.00	12.90	8.77	9.92	11.80
1 00	4.46	5.05	6.01	4.33	4.87	5.80
2 00	2.31	2.61	3.11	2.00	2.26	2.70
3 00	1.63	1.85	2.20	1.15	1.30	1.56
4 00	1.34	1.51	1.80	0.67	0.75	0.90
5 00	1.20	1.35	1.61	0.31	0.35	0.37
6 00	1.15	1.30	1.56	0.00	0.00	0.00

By use of the above table the amount of the azimuth error, resulting from the use of erroneous Declination or Latitude at the different hours of the day, may be determined.

If the South Polar Distance used be too great, the observed meridian falls to the right of the true South Point in the forenoon, and to the left in the afternoon, and vice versa if too small.

If the Latitude used be too great, the observed meridian falls to the left of the true South Point in the forenoon, and to the right in the afternoon, and vice versa if too small.

These results are obtained from the following formulas:

$$dZ = -\frac{d\ \text{Decl.}}{\cos \text{Lat.} \sin \text{Hour Angle}}.$$

$$dZ = +\frac{d\ \text{Lat.}}{\cos \text{Lat.} \tan \text{Hour Angle}}.$$

If 1′ is substituted in the above formulas either for *d* Decl. or *d* Lat. the solution will give the azimuth error in minutes for *dZ*.

The errors resulting from the use of erroneous data for altitude are not so easily determined, but may be found from the formula

$$dZ = \frac{d \text{ Alt.}}{\cos \text{Alt.} \tan S},$$

when S is the parallactic angle or angle at the sun. In using this formula the angle S must first be found, usually by the formula

$$\sin S = \frac{\cos \text{Lat.} \sin Z}{\cos \text{Decl.}}.$$

For latitude 40° and 0° declinations, the results are as given in the following table and they are very nearly the same for other declinations and latitudes around 40°.

ERRORS IN AZIMUTH

No. of hours from noon.	For 1 minute error in altitude.	No. of hours from noon.	For 1 minute error in altitude.
1	4.80	4	1.05
2	2.25	5	0.89
3	1.41	6	0.84

From the above tables it is clear that erroneous data in altitude, declination and latitude affect the resulting azimuth most when the observation is taken near noon, and least when the sun is near the prime vertical, that is east and west. The observation should not be taken within two hours of noon, if this can be avoided. The observation should not be taken when the sun has an altitude of less than about 10°, as the tables of refraction cannot be relied on below *this point.*

As the average transit will not give good results when the sun has an altitude of over 45° or 50°, the surveyor should be careful in the summer time not to get into the field too late in the morning or too early in the afternoon.

The following table gives, for latitude 40°, the altitudes and resulting azimuths for various hour angles and declinations.

H. A.	1		2		3		4		5		6	
Decl.	Alt.	Az.	Alt.	Az.	Alt.	Az.	Alt.	Az.	Alt.	Az.	Alt.	Az.
23° +	68° 48′	41° 12′	59° 31′	65° 09′	48° 34′	79° 38′	37° 08′	90° 15′	25° 42′	99° 20′	14° 33′	108° 01′
20	66 14	37 07	57 29	60 57	46 47	76 03	35 26	87 11	23 58	96 38	12 42	105 34
15	61 46	31 55	53 49	54 54	43 36	70 35	32 26	82 22	20 58	92 18	9 35	101 36
10	57 10	28 03	49 54	49 52	40 10	65 41	29 16	77 51	17 52	88 09	6 24	97 42
5 +	52 29	25 03	45 48	45 36	36 33	61 17	25 57	73 38	14 41	84 08	3 13	93 50
0	47 44	22 38	41 34	41 56	32 48	57 16	22 31	69 38	11 26	80 14	0 00	90 00
5 −	42 56	20 37	37 13	38 43	28 55	53 35	19 00	65 51	8 08	76 25		
10	38 06	18 54	32 48	35 52	24 57	50 11	15 24	62 12	4 48	72 40		
15	33 15	17 24	28 19	33 16	20 54	46 59	11 45	58 42	1 26	68 57		
20	28 23	16 03	23 48	30 54	16 48	43 57	8 03	55 17				
23 −	25 28	15 18	21 04	29 33	14 20	42 12	5 49	53 15				

When tables of logarithmic versines and secants are available Hosmer's formula * gives quicker results than any other formula. The formula is as follows:

$$\log \text{versine Azimuth} = \log [\sin \{90° - (\text{Lat.} + \text{Alt.})\} \pm \sin \text{Decl.}] + \log \sec \text{Lat.} + \log \sec \text{Alt.}$$

Taking as an example the observation previously calculated by McElroy's formula we have

		Lat. 39° 47′	log sec	0.1143
		Alt. 52° 50′	log sec	0.2189
		92° 37′		
		90°		
Nat. sin	−0.0456	co − 2° 37′		
Nat. sin	+0.3475	Decl. +20° 20′		
Alg. sum	0.3019		log	9.4799
			log versine	9.8131

Azimuth of sun 69° 31′

which is the result obtained before.

Another formula for direct sight, not so convenient when many observations are to be worked out, but still useful as a check, is as follows:

$$\text{Sin } \tfrac{1}{2} A = \sqrt{\frac{\sin (S - L) \sin (S - h)}{\cos L \cos h}}.$$

$$S = \frac{L + h + P}{2}.$$

* Hosmer's "Azimuth," John Wiley & Sons, Inc., $1.00. This little book is simply invaluable where many solar or star observations have to be made. The arrangement of tables makes it possible to calculate a direct solar observation in about five minutes by turning over only seven pages of tables arranged in the exact order in which they are to be used in the formula.

A = Azimuth of the sun.

L = Latitude of the place.

h = Altitude of sun less refraction.

p = Sun's polar distance = 90° + the sun's declination when it is south and 90° − the sun's declination when it is north.

Example:

$L = 40° 30'$
$h = 23° 05'$
$p = 107° 03'$

$170° 38' \div 2 = 85° 19' = S.$

$S - L = 44° 49'$ $S - h = 62° 14'$

log sin 44° 49′ = 9.848091
log sin 62° 14′ = 9.946871
log 10 − cos 40° 30′ = 0.118954
log 10 − cos 23° 05′ = 0.036243

2)19.950159

log sin ½ A = 9.975079
½ A = 70° 46′
A = 141° 32′

180° − 141° 32′ = S. 38° 28′ E. Course of observed sun.

As A is here doubled all errors to this point are therefore doubled.

Any of the formulas given may be used to obtain time by solving for the hour angle in place of the azimuth. That is, using the angle at the pole and transposing the remainder of the formula. The solution gives the hour angle in circular measure and this is turned into hours, minutes and seconds as 15° = 1 hour, 15′ = 1 minute and 15″ = 1 second apparent or Sun time. Apparent time is changed to mean solar time by adding or subtracting the equation of time given in the Ephemeris. Mean solar time is changed to standard time, by adding or subtracting

as the case may be, one hour for each 15° of longitude that the observer is distant from the standard meridian.

Where the Azimuth is known the hour angle may be found by the following formula:

$$\sin \text{H. A. (angular measure)} = \frac{\cos \text{Altitude} \sin \text{Azimuth}}{\cos \text{Declination}}$$

Latitude

The latitude is taken from any good map, such as those of the United States Geological Survey, and carried from the initial point when necessary. At latitude 40°, one minute of latitude equals 6,070 feet, or one mile equals 52 seconds of latitude. A surveyor doing considerable work in one district will prepare a table showing cosines and tangents for latitudes likely to be of use, and thus avoid looking them up in a large table every time an observation is figured.

When the latitude is known approximately, observations may be taken at equal intervals before and after apparent noon, and various figures for latitude tried till one is found which gives the same azimuth in the morning as in the afternoon. When the latitude is absolutely unknown, it may be found as follows: Set up the instrument in plenty of time before apparent noon. Bisect the sun with vertical cross wire and either bisect it with horizontal cross wire, or place tangent. Follow the sun till it ceases to rise. Care must be taken in the observation to allow plenty of space through which the tangent screws may be moved, otherwise they are liable to give out at a critical moment. As the instrument cannot be reversed as in the case of the direct sight, it is well to level the telescope immediately after the observation and note the index error, adding or

subtracting it for the angle observed. In instruments with a movable arc, the arc had best be set at zero immediately after getting the sun. The telescope is then leveled and the angle read, thus avoiding errors incidental to settling of the instrument during a long observation.

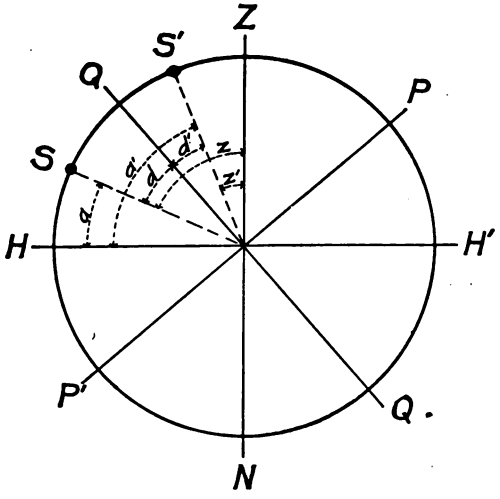


FIG. 6

When the observer is north of the equator the latitude then equals the zenith distance plus or minus the declination for apparent noon. Lat. = (90° − altitude *) + declination, when the sun is north of the equator, and Lat. = (90° − altitude*) − declination, when the sun is south of the equator.

When the observer is south of the equator the above is reversed.

In Fig. 6, which represents a section of the celestial sphere on the meridian, we have *ZN* Zenith to Nadir line,

* (*Corrected* for refraction.)

PP' line joining the poles, QQ the equator, and HH' the horizon, while S and S' show the position of the sun, Z and Z' the zenith distance, a and a' the altitude, and d and d' the declinations, respectively, when the sun is south or north of the equator and the observer in north latitude.

Example: October 20, 1905; 12 m.; Longitude 105° 30′ + W.

Altitude sun's upper limb	= 40° 15′
Less refraction	= 0° 1′
Less semi-diameter	= 0° 16′
Altitude sun's center	= 39° 58′
Declination Greenwich A. T.	= 10° 11′ 50″
Diff. 1 hr. = 54.01. Diff. 7 hrs.	= 6′ 30″
Declin. longitude 105° 30′ + W.	= 10° 18′ 20″
	90° 00′
	39° 58′
	50° 2′
	10° 18′ 20″
Latitude place of observation	= 39° 43′ 40″

In the case of observations made in summer, it will be necessary to use an auxiliary telescope such as is used in shaft surveying, as the sun will be too high for the ordinary telescope. In latitude 40° declination 23° 30′ N., the altitude of the sun will be 73° 30′. If no auxiliary telescope is available it will be necessary to make an observation on Polaris * for latitude, or use some other method.

* Hosmer's Azimuth previously mentioned.

CHAPTER II

SOLAR ATTACHMENTS

The Shattuck Solar Attachment

Figure 7 is a sectional view in the plane of the Shattuck Patent Double Reflecting Solar Attachment, perpendicular to both reflectors and the pivot of the arm *D*.

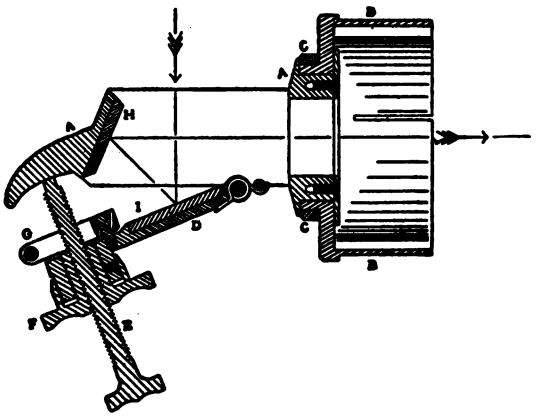


FIG. 7

The frame *AA*, which carries the stationary mirror *H*, revolves about a main axis called the polar axis, coincident with the line of collimation, by means of a bearing in the cap *B*, and is held in place by two screws and a spring washer. It is provided with a clamp ring *C*, which may be clamped to a cap *B* by means of a clamp screw. A slow motion is obtained by means of a tangent screw and spring plunger (not *shown*) at the base of the frame AA.

D is a swinging arm pivoted in the frame *AA* as shown and provided with a coiled spring which keeps the adjusting screw *E* constantly in contact with the surface of the lug on the outer end of the frame. This swinging arm carries the movable mirror *I*, the adjusting screw *E* for setting off the declination, the differential nut *F* for setting off the hourly change in declination, and the clamp *G* for clamping the screw *E* when turning the nut *F*.

The ray of light from the sun or star enters from above, as indicated by the arrow, impinges upon the mirror *I*, is thence reflected to the mirror *H*, thence through the opening in the base of the frame *AA*, and through the object glass to the cross hairs of the transit.

The sun's declination, corrected for refraction, is set off by means of the screw *E* with the aid of the limb of the transit, as will be explained later. The hourly change in the sun's declination between the first and subsequent readings during the day is corrected by means of the graduated differential nut *F*, each division of which represents one minute of arc and is turned to the right or left according as the declination is increasing to the north or to the south.

The cap *B* is fitted to the objective end of the transit.

The sun, in its apparent diurnal motion about the polar axis, follows a path parallel to the celestial equator at a certain angular distance from the poles. When this angle is set off by means of the solar attachment, and the sight-line of the telescope is set at an angle with the horizon equal to the latitude of the place, it is evident that it is impossible to view the sun on the cross wires and follow it by turning the attachment on its axis except the instrument be in the plane of the meridian with the sight-line *parallel to the* polar axis.

Determination of Meridian

To Determine the Meridian with the Shattuck Patent Double Reflecting Solar Attachment, assuming the sun's corrected declination for the day and hour of observation to be North 11° 26′:

First. Sight at some point on the horizon (*B*, Fig. 8) with the solar attachment off, the telescope level and the

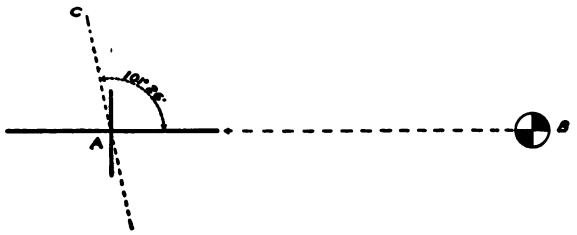


FIG. 8

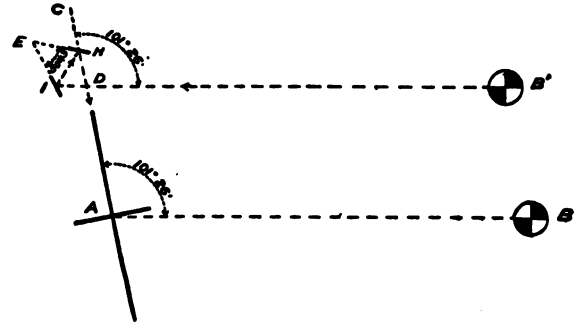


FIG. 9

vernier set at 101° 26′ (90° + 11° 26′), the corrected south polar distance, Fig. 8, being an illustration.

Second. With the lower plate clamped, turn the vernier of the horizontal limb to zero and with the solar attachment *in place, as shown* by Fig. 9, sight the same objec

(B', Fig. 9), bringing it to the cross hairs by means of the adjusting screw E, which may then be clamped with the clamp G, Fig. 7.

Should the object sighted be less than about a mile distant — depending somewhat on the focal length of the telescope — allowance should be made for the distance from the axis of the instrument to the optical center of the solar attachment, as shown graphically in Fig. 9, where A is the axis of the instrument, B is the first point sighted, and B' the second point with solar attachment in place; the angle CAB equals the angle CDB' and the distance AD equals the distance BB'. With a little practice this distance can be readily estimated on distant fence posts, bricks in houses, tree-trunks or other natural objects.

At great distances the distance BB' becomes inappreciable and is ignored. The angle CDB' will remain at 101° 26′ so long as the angle HEI (the angle between the reflectors) remains at 50° 43′ (101° + 26′ ÷ 2), regardless of minor defects in the polar bearings of the attachment.

The lower clamp may now be released.

Third. Depress the objective of the telescope until the vernier of the vertical circle or arc is set at an angle equal to the latitude of the place of observation.

Bring the sun's image to the proper position on the cross wires of the instrument by turning the transit on its vertical axis (using the lower clamp and tangent screw for its fine adjustment) and the solar attachment upon its polar axis. The sun's image will be in the field of view when the light from the fixed mirror is seen to pass exactly through the opening in the base of the frame.

After the sun's image has been bisected, as shown in Fig. 10, the bisection may be successively checked by turn*ing the tangent* screw engaging the ring C, Fig. 7.

The axis of the telescope is now parallel to the earth's axis and the instrument is in the plane of the meridian with the vernier of the horizontal limb set at zero. The solar attachment may now be removed and the azimuth of any desired object taken.

If the transit is not provided with solar wires as shown in Fig. 10, set off on the vertical circle the latitude minus

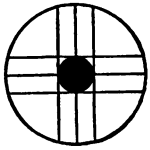


Fig. 10

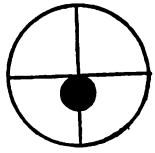


Fig. 11

the sun's semi-diameter as given in the Ephemeris, and then bring the upper limb or edge of the sun to the intersection of the cross hairs as shown in Fig. 11, which can be done with great precision.

Fig. 12 is a diagram illustrating the transit with solar attachment set in the meridian. A is the axis of the transit, PP' the polar axis, NS the meridian. The sun's declination being north, the south polar distance is 90° plus the corrected declination.

If the transit has a full vertical circle, the errors of adjustment may be eliminated by taking the mean between normal and reverse observations, as in the case of the direct solar observation.

Observations on fixed stars for the meridian or latitude are made with the solar attachment in exactly the same manner as on the sun. There being no appreciable hourly change in the declination of the fixed stars, the refraction

correction for the proper hour angle is applied directly to the apparent declination.

The writer has obtained perfect checks on the Shattuck solar by direct observation of the sun, and considers it the best solar made.

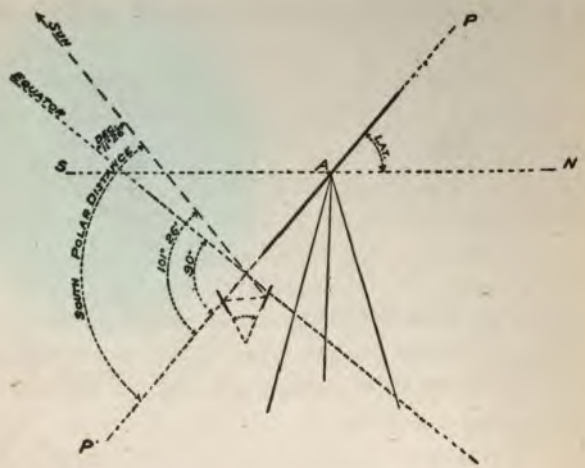


Fig. 12

To Determine the Latitude with the Shattuck Solar

Carefully set off in the solar the south polar distance of the sun at apparent noon, corrected for the refraction at that hour, in the same manner as previously explained.

About fifteen minutes before noon, direct the telescope with the solar attached, toward the lower pole; then move the transit on its vertical axis and the solar on the polar axis until the reflected light of the sun from the fixed mirror is seen to pass exactly through the opening in the base of the frame, with the sides of the solar as nearly

vertical as possible. The sun's image will then be in the field of view.

Now bring the upper limb or edge of the sun to the horizontal cross wire by turning the tangent screw of the telescope axis; then by turning the tangent screw of the polar axis of the solar, cause the sun's image to pass rapidly across the field of view. If the limb of the sun passes parallel to the horizontal wire, the plane of the solar is in a vertical position; but if not, turn the solar on the polar axis and the transit on its vertical axis, until the plane is vertical as shown by this test.

Keeping the plane of solar vertical, follow the sun's upper limb with the horizontal cross wire, by turning the tangent screw of the telescope axis, as long as the sun continues to rise.

The sun is at its greatest altitude when it reaches the meridian; therefore, at apparent noon, when the sun's image ceases to rise, take the reading of the vertical circle and add to it the sun's semi-diameter as given in the Ephemeris, which will give the required latitude. This is illustrated in Fig. 12.

Use of Solar Ephemeris

The sun's declination at Greenwich mean noon is given in the Ephemeris for every day in the year.

Local time at different points on the earth's surface varies at the rate of one hour for every 15 degrees of longitude; the more easterly the place the later the local time.

When it is noon according to "Eastern" (75th meridian), "Central" (90th meridian), "Mountain" (105th meridian), or "Pacific" (120th meridian) time, it is five, six, seven or eight hours, respectively, after noon at Greenwich. *Hence, for example,* to determine the declination at

9 o'clock, A.M., "Mountain Time," which is four hours (seven hours minus three hours) after mean noon at Greenwich, the given difference for one hour is multiplied by four, which gives the correction to be applied to the given declination, noting carefully the algebraic signs of both the declination and hourly difference as given in the Ephemeris.

In using the Shattuck solar attachment, the refraction correction is always positive, and is always added to the South Polar distance, and subtracted from the North Polar distance when making observations in the Northern Hemisphere.

The declination of the sun being its distance from the celestial equator, the South Polar distance is 90° plus or minus the declination, according as the sun is north or south of the equator.

This refraction is found under the description of the Burt Solar, in a table for various latitudes and periods before and after noon.

Example:

Required the south polar distance of the sun at 3 P.M., "Mountain Time," May 28, 1902, latitude 40°.

The time is 10 hours (7 + 3) after noon at Greenwich.

Hourly difference	+ 24.79″
× Number of hours	10
Total change in declination	+247.9″ or + 4′ 07.9″
Declination at Greenwich noon	+21° 21′ 12.0″
Required declination	+21° 25′ 19.9″
Refraction (hour angle 3)	+00′ 33.0″
Corrected apparent declination	+21° 25′ 52.9″
Declination being north, add	90°
South polar distance	111° 25′ 52.9″

To save time, it is advisable, before going into the field, to prepare a table for the day, giving the south polar distances of the sun for every hour suitable for taking observations.*

The Burt Solar Attachment †

In Fig. 13 we have a graphic illustration of the Burt solar apparatus, the circles shown being intended to represent those supposed to be drawn upon the concave surface of the heavens.

When the telescope is set horizontal by its spirit-level, the hour-circle will be in the plane of the horizon, the polar axis will point to the zenith, and the zeros of the vertical arc and its vernier will coincide. Now if we incline the telescope, directed north as shown in the cut, the polar axis will descend from the direction of the zenith. The angle through which it moves, being laid off on the vertical arc, will be the co-latitude of the place where the instrument is supposed to be used, the latitude itself being found by subtracting this number from 90°.

When, however, the sun passes above or below the equator, his declination, or angular distance from it, as given in the Ephemeris, can be set off upon the arc, and his image brought into position as before.

In order to do this, however, it is necessary not only that the latitude and declination be correctly set off upon their respective arcs, but also that the instrument be moved in azimuth until the polar axis points to the pole of the heavens, or, in other words, is placed in the plane of the meridian; and thus the position of the sun's image

* The methods of figuring declination and refraction are given more fully under the description of the Burt Solar.

† *Taken by permission from* Gurley's "Manual."

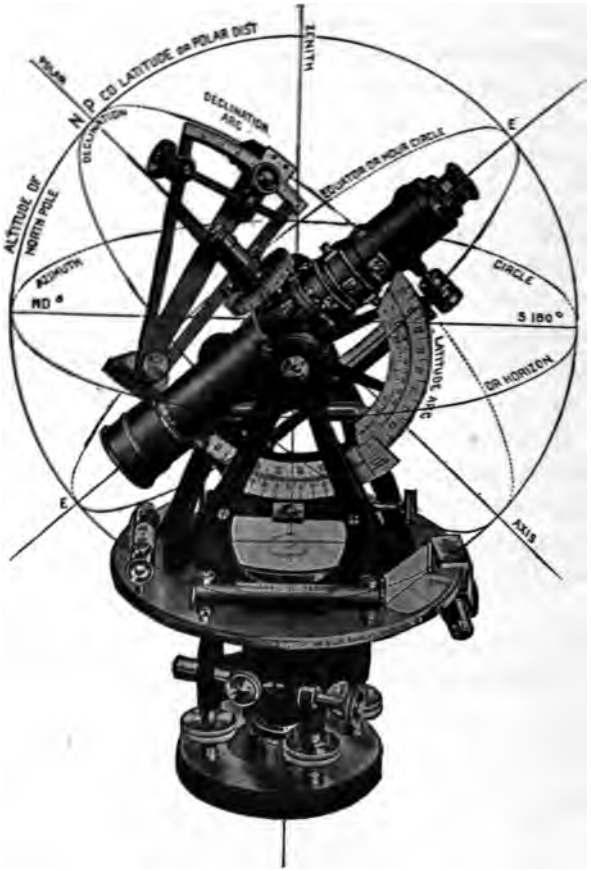


Fig. 13

will indicate not only the latitude of the place, the declination of the sun for the given hour and the apparent time, but will also determine the meridian, or true north and south line passing through the place where the observation is made.

The interval between two equatorial lines, *cc*, as well

as between the hour lines, *bb* (Fig. 14), is just sufficient to include the circular image of the sun, as formed by the solar lens on the opposite side of the revolving arm.

Allowance for declination: Let us now suppose the observation made when the sun has passed the equinoctial point, and when his position is affected by declination.

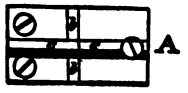


Fig. 14

By referring to the Ephemeris, and setting off on the arc his declination for the given day and hour, we are still able to determine his position with the same certainty as if he remained on the equator.

When the sun's declination is south, that is, from the 22nd of September to the 20th of March, in each year, the arc is turned downward, or towards the plates of the transit, while during the remainder of the year the arc is turned from the plates.

When the solar attachment is accurately adjusted and its plates made perfectly horizontal, the latitude of the place (co-latitude from horizontal) and the declination of the sun for the given day and hour being also set off on their respective arcs, and the instrument set approximately north by the magnetic needle, the image of the sun cannot be brought between the equatorial lines until the polar axis is placed in the plane of the meridian of the place, or in a position parallel with the axis of the earth.

The slightest deviation from this position will cause the image to pass above or below the lines, and thus discover the error.

To Run Lines with the Burt Solar Attachment

Having set off the latitude of the place (co-latitude from *horizontal) on the vertical* arc, and the declination for th

given day and hour as computed from the tables in the solar Ephemeris, the instrument being also carefully leveled by the telescope bubble, set the horizontal limb at zero and clamp the plates, loosen the lower screw so that the transit moves easily upon its lower socket, set the instrument approximately north and south, with the object-glass end of the telescope towards the north, turn the proper solar lens to the sun, and with one hand on the plates and the other on the revolving arm move them from side to side until the sun's image is brought between the equatorial lines on the silver plate.

The lower clamp of the instrument should now be fastened, and any further lateral movement be made by the tangent screw of the leveling head. The necessary allowance being made for refraction, the telescope will be in the true meridian from which any lines desired may be deflected.

The declination of the sun given in the Ephemeris, or Nautical Almanac, from year to year, is calculated for apparent noon at Greenwich, England.

To determine it for any other hour at a place in the United States, reference must be had, not only to the difference of time arising from the difference of longitude, but also to the change of declination during that time.

The longitude of the place, and therefore its difference in time, if not given directly in the ephemeris, can be ascertained very nearly by reference to that of other places given which are situated on, or very nearly on, the same meridian.

It is the practice of surveyors in states east of the Mississippi to allow a difference of six hours for the difference in longitude, calling the declination given in the Ephemeris for 12 M. that of 6 A.M. at the place of observation.

Beyond the meridian of Santa Fé, the allowance would be about seven hours; and in California, Oregon and Washington about eight hours.

Having thus the difference of time, we very readily obtain the declination for a certain hour in the morning, which would be earlier or later as the longitude was greater or less, and the same as that of apparent noon at Greenwich on the given day. Thus, suppose the observation to be made at a place five hours later than Greenwich, then the declination given in the Ephemeris for the given day at noon, affected by the refraction, would be the declination at the place of observation for 7 A.M.; this gives us the starting point.

To obtain the declination for the other hours of the day, take from the Ephemeris the declination for apparent noon for the given day, and, as the declination is increasing or decreasing, add to, or subtract from, the declination of the first hour the difference for one hour as given in the Ephemeris, which will give, when affected by the refraction, the declination for the succeeding hour; and proceed thus in making a table of declination for every hour of the day.

The table of refractions is calculated for latitudes between 15° and 60° at intervals of 2½°, that being as near as is required.

The declination ranges from 0° to 20° both north and south, the + declinations being north and the − south, and is given for every 5°, that being sufficiently near for all practical purposes. The hour angle in the first column indicates the distance of the sun from the meridian in hours, the refraction given for 0 hours being that which affects the observed declination of the sun when on the meridian, commonly known as the meridional refraction; the refraction for the hour just before or after noon is so

nearly that of the meridian that it may be called and allowed as the same.

When the table is used it must be borne in mind that when the declination is north, or + in the table, the refraction is to be added; when the declination is south, or −, the refraction must be subtracted. It will be noted that the refraction in south declination increases very rapidly as the sun nears the horizon, showing that observations should not be taken with sun when south of the equator, less than one hour from the horizon.

To Compute the Declination

Suppose it was required to obtain the declination for the different hours of April 16, 1895, at Troy, New York.

The longitude in time is four hours, fifty-four minutes and forty seconds, or practically five hours; so that the declination given in the Ephemeris for apparent noon of that day at Greenwich would be that of 7 A.M. at Troy.

DECLINATION AT GREENWICH AT NOON OF APRIL 16, 1895

N. 10° 7′ 56.5″

								Troy
N. 10°	7′	56.5″	+ Refr. 5 hrs.	1′	58″	= 10° 9′ 54″	= Dec.	7 A.M.
add	hr. dif.	53.2″						
10°	8′	49.7″	+ Refr. 4 hrs.	1′	11″	= 10° 10′ 00″	= Dec.	8 A.M.
		53.2						
10°	9′	42.9″	+ Refr. 3 hrs.		52″	= 10° 10′ 34″	= Dec.	9 A.M.
		53.2″						
10°	10′	36.1″	+ Refr. 2 hrs.		39″	= 10° 11′ 15″	= Dec.	10 A.M.
		53.2″						
10°	11′	29.3″	+ Refr. 1 hr.		36″	= 10° 12′ 05″	= Dec.	11 A.M.
		53.2″						
10°	12′	22.5″	+ Refr. 0 hrs.		36″	= 10° 12′ 58″	= Dec.	12 M.
		53.2″						
10°	13′	15.7″	+ Refr. 1 hr.		36″	= 10° 13′ 51″	= Dec.	1 P.M.
		53.2″						
10°	14′	08.9″	+ Refr. 2 hrs.		39″	= 10° 14′ 47″	= Dec.	2 P.M.
		53.2″						
10°	15′	02.1″	+ Refr. 3 hrs.		52″	= 10° 15′ 54″	= Dec.	3 P.M.
		53.2″						
10°	15′	55.3″	+ Refr. 4 hrs.	1′	11″	= 10° 17′ 06″	= Dec.	4 P.M.
		53.2″						
10°	16′	48.5″	+ Refr. 5 hrs.	1′	58″	= 10° 18′ 46″	= Dec.	5 P.M.

Again, suppose it was desired to obtain the corrected declination for the different hours of October 16, 1895, at Troy, New York.

The difference in time being nearly five hours, and the declination at Greenwich, noon, 8° 53′ 53.6″, that declination affected by the refraction would give the true declination for 7 A.M. at Troy; the latitude being nearly 42° 30′. The declination *being* now south, the refraction is to b

subtracted, but the hourly difference is to be added because the declination is increasing, as in the first example; thus:

				Troy
S.	8° 53′ 53.6″	— Refr. 5 hrs. 9′ 24″	= 8° 44′ 30″ = Dec.	7 A.M.
add hr. dif.	55.3″			
	8° 54′ 48.9″	— Refr. 4 hrs. 2′ 49″	= 8° 52′ 00″ = Dec.	8 A.M.
	55.3″			
	8° 55′ 44.2″	— Refr. 3 hrs. 1′ 49″	= 8° 53′ 55″ = Dec.	9 A.M.
	55.3″			
	8° 56′ 39.5″	— Refr. 2 hrs. 1′ 26″	= 8° 55′ 13″ = Dec.	10 A.M.
	55.3″			
	8° 57′ 34.8″	— Refr. 1 hr. 1′ 14″	= 8° 56′ 21″ = Dec.	11 A.M.
	55.3″			
	8° 58′ 30.1″	— Refr. 0 hrs. 1′ 14″	= 8° 57′ 16″ = Dec.	12 M.
	55.3″			
	8° 59′ 25.4″	— Refr. 1 hr. 1′ 14″	= 8° 58′ 11″ = Dec.	1 P.M.
	55.3″			
	9° 00′ 20.7″	— Refr. 2 hrs. 1′ 26″	= 8° 58′ 55″ = Dec.	2 P.M.
	55.3″			
	9° 01′ 16.0″	— Refr. 3 hrs. 1′ 49″	= 8° 58′ 27″ = Dec.	3 P.M.
	55.3″			
	9° 02′ 11.3″	— Refr. 4 hrs. 2′ 49″	= 8° 59′ 22″ = Dec.	4 P.M.
	55.3″			
	9° 63′ 06.6″	— Refr. 5 hrs. 9′ 24″	= 8° 53′ 43″ = Dec.	5 P.M.

These calculations should of course be made before the surveyor begins work in the field.

A Table of Mean Refractions in Declination to be Used with the Shattuck and Burt Solar Attachments

Apply to the declination as found in the ephemeris

DECLINATIONS.

Hour angle.	For latitude 15°.								
	+20°	+15°	+10°	+5°	0°	−5°	−10°	−15°	−20°
0 h.	−05″	0″	+05″	10″	15″	21″	27″	33″	40″
2	03	+02	07	12	18	23	29	36	43
3	+01	05	11	16	22	28	34	41	49
4	08	12	19	24	30	37	44	53	1′ 04
5	29	34	41	49	59	1′ 10	1′ 24	1′ 43	2 08
	For latitude 17° 30′.								
0 h.	−02″	+02″	08″	13″	18″	24″	30″	36″	44″
2	0	05	10	15	21	27	33	40	48
3	+02	10	15	21	27	33	40	48	57
4	13	18	23	29	35	43	51	1′ 01	1′ 13
5	34	41	49	58	1′ 10	1′ 23	1′ 41	2′ 06	2 42
	For latitude 20°.								
0 h.	0″	05″	10″	15″	21″	27″	33″	40″	48″
2	03	07	13	18	24	30	36	44	52
3	06	13	18	24	30	36	44	52	1′ 02
4	17	22	28	35	42	50	1′ 00	1′ 11	1 26
5	39	47	57	1′ 07	1′ 20	1′ 37	2 00	2 32	3 25
	For latitude 22° 30′.								
0 h.	02″	08″	13″	18″	24″	30″	36″	44″	52″
2	06	11	15	21	27	33	40	48	57
3	11	15	21	27	33	40	48	57	1′ 08
4	20	26	32	39	46	56	1′ 07	1′ 19	1 37
5	45	53	1′ 03	1′ 16	1′ 31	1′ 52	2 21	3 07	4 28
	For latitude 25°.								
0 h.	05″	10″	15″	21″	27″	33″	40″	48″	57″
2	08	14	19	25	31	38	46	54	1′ 05
3	12	18	24	30	37	44	53	1′ 04	1 18
4	23	29	35	45	53	1′ 03	1′ 16	1 31	1 52
5	49	59	1′ 10	1′ 24	1′ 52	2 07	2 44	3 46	5 43

DECLINATIONS.

Hour angle.	+20°	+15°	+10°	+5°	0°	−5°	−10°	−15°	−20°
	For latitude 27° 30′.								
0 h.	08″	13″	18″	24″	30″	36″	44″	52″	1′ 02″
2	11	16	22	28	34	41	49	1′ 00	1 10
3	17	22	28	35	42	50	1′ 00	1 11	1 26
4	28	35	42	50	1′ 00	1′ 11	1 26	1 43	2 09
5	54	1′ 05	1′ 18	1′ 34	1 54	2 24	3 11	4 38	8 15
	For latitude 30°.								
0 h.	10″	15″	21″	27″	33″	40″	48″	57″	1′ 08″
2	14	19	25	31	38	46	54	1′ 05	1 18
3	20	26	32	39	47	55	1′ 06	1 19	1 36
4	32	39	46	52	1′ 06	1′ 19	1 35	1 57	2 29
5	1′ 00	1′ 10	1′ 24	1′ 52	2 07	2 44	3 46	5 43	13 06
	For latitude 32° 30′.								
0 h.	13″	18″	24″	30″	36″	44″	52″	1′ 02″	1′ 14″
2	17	22	28	35	42	50	1′ 00	1 11	1 26
3	23	29	35	43	51	1′ 01	1 13	1 28	1 47
4	35	43	51	1′ 01	1′ 13	1 27	1 46	2 13	2 54
5	1′ 03	1′ 15	1′ 31	1 53	2 20	3 05	4 25	7 36	
	For latitude 35°.								
0 h.	15″	21″	27″	33″	40″	48″	57″	1′ 08″	1′ 21″
2	20	25	32	38	46	55	1′ 05	1 18	1 35
3	26	33	39	47	56	1′ 07	1 21	1 38	2 00
4	39	47	56	1′ 07	1′ 20	1 36	1 59	2 32	3 25
5	1′ 07	1′ 20	1′ 38	2 00	2 34	3 29	5 14	10 16	
	For latitude 37° 30′.								
0 h.	18″	24″	30″	36″	44″	52″	1′ 02″	1′ 14″	1′ 29″
2	22	28	35	42	50	1′ 00	1 12	1 26	1 45
3	29	36	43	52	1′ 02	1 14	1 29	1 49	2 16
4	43	51	1′ 01	1′ 13	1 27	1 49	2 14	2 54	4 05
5	1′ 11	1′ 26	1 54	2 10	2 43	3 55	6 15	14 58	

DECLINATIONS.

Hour angle.	For latitude 40°.								
	+20°	+15°	+10°	+5°	0°	−5°	−10°	−15°	−20°
0 h.	21″	27″	33″	40″	48″	57″	1′ 08″	1′ 21″	1′ 39″
2	25	32	39	46	52	1′ 06	1 19	1 35	1 57
3	33	40	48	57	1′ 08	1 21	1 38	2 02	2 36
4	47	55	1′ 06	1′ 19	1 36	1 58	2 30	3 21	4 59
5	1′ 15	1′ 31	1 51	2 20	3 05	4 25	7 34	25 18	
	For latitude 42° 30′.								
0 h.	24″	30″	36″	44″	52″	1′ 02″	1′ 14″	1′ 29″	1′ 49″
2	28	35	39	50	1 00	1 12	1 26	1 45	2 11
3	36	43	52	1′ 02	1 13	1 29	1 49	2 17	2 59
4	50	1′ 00	1′ 11	1 26	1 44	2 10	2 49	3 55	6 16
5	1′ 16	1 36	1 58	2 30	3 22	5 00	9 24		
	For latitude 45°.								
0 h.	27″	33″	40″	48″	57″	1′ 08″	1′ 21″	1′ 39″	2′ 02″
2	32	39	46	52	1′ 06	1 19	1 35	1 57	2 29
3	40	47	56	1′ 07	1 21	1 38	2 00	2 34	3 29
4	54	1 04	1′ 16	1 33	1 54	2 24	3 11	4 38	8 15
5	1′ 23	1 41	2 05	2 41	3 40	5 40	12 02		
	For latitude 47° 30′.								
0 h.	30″	36″	44″	52″	1′ 02″	1′ 14″	1′ 29″	1′ 49″	2′ 18″
2	35	42	50	1′ 00	1 12	1 26	1 45	2 01	2 51
3	43	51	1′ 01	1 13	1 28	1 47	2 15	2 56	4 08
4	56	1′ 09	1 23	1 40	2 05	2 40	3 39	5 37	11 18
5	1′ 27	1 46	2 12	2 52	4 01	6 30	16 19		
	For latitude 50°.								
0 h.	33″	40″	48″	57″	1′ 08″	1′ 21″	1′ 39″	2′ 02″	2′ 36″
2	38	46	55	1′ 06	1 18	1 35	1 57	2 28	3 19
3	47	56	1′ 06	1 19	1 36	2 29	2 31	3 23	5 02
4	1′ 02	1′ 14	1 29	1 48	2 16	2 58	4 18	6 59	19 47
5	1 30	1 51	2 19	3 04	4 22	7 28	24 10		

DECLINATIONS.

Hour angle.	For latitude 52° 30′.								
	+20°	+15°	+10°	+5°	0°	−5°	−10°	−15°	−20°
0 h.	36″	44″	52″	1′ 02″	1′ 14″	1′ 29″	1′ 49″	2′ 18″	3′ 05″
2	43	50	59	1 11	1 26	1 42	2 23	2 49	3 55
3	50	1′ 00	1′ 11	1 26	1 45	2 11	2 51	2 58	6 22
4	1′ 05	1 18	1 35	2 10	2 28	3 19	4 53	8 42	
5	1 34	1 56	2 27	3 16	4 47	8 52			
For latitude 55°.									
0 h.	40″	48″	57″	1′ 08″	1′ 21″	1′ 39″	2′ 02″	2′ 36″	3′ 33″
2	46	55	1′ 05	1 18	1 34	1 56	2 30	3 15	4 47
3	55	1′ 06	1 19	1 35	1 58	2 30	3 21	4 58	9 19
4	1′ 10	1 23	1 42	2 06	2 43	3 44	5 49	12 41	
5	1 37	2 01	2 34	3 28	5 15	10 18			
For latitude 57° 30′.									
0 h.	44″	52″	1′ 02″	1′ 14″	1′ 29″	1′ 49″	2′ 18″	3′ 05″	4′ 37″
2	50	59	1 11	1 25	1 43	2 09	2 47	3 51	6 04
3	58	1′ 10	1 24	1 42	2 07	2 43	3 45	5 50	12 47
4	1′ 11	1 25	1 43	2 10	2 50	3 55	6 14	14 49	
5	1 41	2 06	2 42	3 42	5 46	12 26			
For latitude 60°.									
0 h.	48″	57″	1′ 08″	1′ 21″	1 39″	2′ 02″	2′ 36″	3′ 33″	5′ 23′
2	54	1′ 04	1 17	1 33	1 54	2 24	3 12	4 38	8 15
3	1′ 03	1 15	1 30	1 51	2 20	3 04	4 24	7 31	24 44
4	1 18	1 34	1 56	2 28	3 18	4 50	8 53		
5	1 45	2 11	2 50	3 57	6 21	15 32			

To Find the Latitude with the Burt Solar Attachment

First, level the instrument very carefully, using the level of the telescope, as before, until the bubble will remain in the middle during a complete revolution of the instrument, the tangent movement of the telescope being used in connection with the leveling-screws of the parallel plates, and the axis of the telescope being firmly clamped.

Next, clamp the vertical arc, so that its zero and the zero of its vernier coincide as near as may be, and then bring them into exact line by the tangent screw of the vernier.

Then, having the declination of the sun for 12 o'clock of the given day as affected by the meridional refraction carefully set off upon the declination arc, note also the equation of time; and fifteen or twenty minutes before noon, the telescope being directed to the north and the object-glass end lowered until, by moving the instrument upon its spindle and the declination arc from side to side, the sun's image is brought nearly into position between the equatorial lines. Now bring the declination arc directly in line with the telescope, clamp the axis, and with the tangent screw of the telescope axis bring the image precisely between the lines and keep it there with the tangent screw, raising it as long as it runs below the lower equatorial line, or, in other words, as long as the sun continues to rise in the heavens.

When the sun reaches the meridian the image will remain stationary in altitude for an instant, and will then begin to rise on the plate.

The moment the image ceases to run below is, of course, apparent noon, when the index of the hour arc should indicate XII, and the latitude be determined by the reading *of the vertical arc.*

The angle through which the polar axis has moved in the operation just described is measured from the zenith instead of from the horizon, so that the angle read on the vertical limb is the complement of the latitude or co-latitude.

To Adjust the Burt Solar Attachment

The declination arm is first detached by removing the clamp and tangent screws and the center with its small screws, by which the arm is attached to the arc.

The adjuster, which is a short bar furnished with every instrument, is then substituted for the declination arm, the center screwed into its place at one end, and the clamp screw into the other, being inserted through the hole left by the removal of the tangent screw, thus securing the adjuster firmly to the arc.

The declination arm is then placed on the adjuster, one end is turned to the sun, and brought into such a position that the image of the sun is brought precisely between the equatorial lines on the opposite plate.

Carefully turn the arm over, until it rests upon the adjuster by the opposite faces of the rectangular blocks, and again observe the sun's image. If it remains between the lines as before, the arm is in adjustment. If not, loosen the three small screws which hold it to the arm, and move the silver plate under their heads until one-half the error in the position of the sun's image is removed.

Bring the image again between the lines, and repeat the operation as above on both ends of the arm, until the image will remain between the lines of the plate in both positions of the arm, when it will be in proper adjustment, and the arm may be replaced in its former position on the

ient. This adjustment is very rarely needed in these

instruments, the lenses being cemented in their cells and the plates securely fastened.

To Adjust the Vernier of the Declination Arc: Set the vernier at zero, and then raise or lower the telescope until the sun's image appears exactly between the equatorial lines.

Having the telescope axis clamped, carefully revolve the arm until the image appears on the other plate. If precisely between the lines, the adjustment is complete; if not, move the declination arm by its tangent screw until the image will come precisely between the lines on the two opposite plates; clamp the arm and remove the index error by loosening two screws that fasten the vernier; place the zeros of the vernier and limb in exact coincidence, tighten the screws, and the adjustment is complete.

To Adjust the Polar Axis: First, level the instrument carefully by the long level of the telescope, using in the operation the tangent movement of the telescope axis in connection with the leveling-screws of the parallel plates, until the bubble will appear in the middle during a complete revolution of the instrument upon its axis.

Place the solar apparatus upon the axis and see that it moves easily around it; bring the declination arm in the same vertical plane with the telescope; place the adjusting level upon the top of the rectangular blocks, and bring the bubble into the middle by the tangent screw of the declination arc.

Then turn the arc half way around, bringing it again parallel with telescope, and note the position of the level. If in the middle, the polar axis is vertical in that direction; if not in the middle, correct one-half of the error by the capstan-head adjusting screws under the base of the polar axis, moving each screw of the pair the same amount, but

in an opposite direction. Bring the level to the middle again by the tangent screw of the declination arc, and repeat the operation as before, until the bubble will remain in the middle when the adjusting-level is reversed.

Pursue the same course in adjusting the arc in the second position, or over the telescope axis, and when completed the level will remain in the middle during an entire revolution of the arc, showing that the polar axis is at right angles with the level under the telescope, or truly vertical.

Care should be taken that the level under the telescope is kept in the middle, and the capstan-screws brought to a firm bearing.

The adjusting-level in the operation just described is supposed to be itself in adjustment; but if not, it can be easily corrected by the screw shown at one end, when reversed upon a plane surface, exactly as a mason's level is adjusted.

As this is by far the most delicate and important adjustment of the solar attachment, it should be made with the greatest care, the bubble kept perfectly in the middle and frequently inspected in the course of the adjustment.

To Adjust the Hour-Arc: Whenever the instrument is set in the meridian, as will be hereafter described, the index of the hour-arc should read apparent time. If not, loosen the two flat head screws on the top of the hour-circle, and with the hand turn the circle around until it does, fasten the screws again, and the adjustment will be complete.

To obtain mean time, the correction of the equation for the given day, as found in the Nautical Almanac, should always be applied.

Berger and Saegmuller Solars

The principle of these two solar attachments is the same. (Fig. 15 *A* and *B*.) The declination of the sun for the place and hour required is figured as previously shown. This declination is regarded as plus or minus as it is north or south, and added algebraically to the refraction which

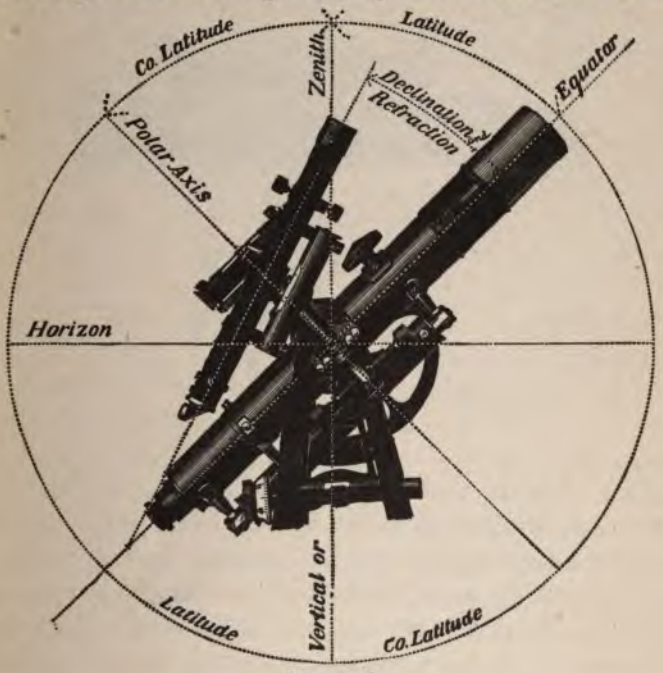


Fig. 15 *A*

is always plus. The refraction is found from the table previously given for the Burt and Shattuck solars or for each day and hour in the Ephemeris issued for the Saegmuller solar. The declination corrected for refraction being determined, the instrument provided with the solar (see *Fig. 15 A and B*) is carefully leveled, and the line of

collimation of the solar and main telescope made parallel by sighting at some distant object. The declination is now set off on the vertical arc or circle of the transit by depressing the telescope when the declination is north, and raising the telescope when the declination is south. The solar telescope is then leveled by means of its attached

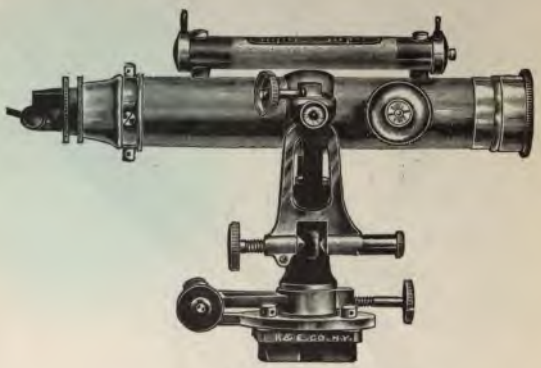


Fig. 15 *B*

bubble with the main telescope still clamped. The co-latitude is then set off on the vertical circle of the transit, and the solar telescope directed towards the sun, which is bisected exactly as in the case of the direct observation. This is done by turning the solar on its vertical axis and by means of the lower motion of the transit. If the horizontal plates have been previously clamped at 0°, with the lower motion unclamped, as soon as the sun is bisected by the solar telescope, the main telescope is necessarily pointing due south. If now the lower motion is clamped and the upper motion free, the direction of the main telescope as read on the horizontal plates will give the correct *bearing.*

By an ingenious attachment called an equatorial adaptor, the auxiliary telescope made by C. L. Berger and used in sighting down steep shafts may be used exactly as the Saegmuller solar.

CHAPTER III

MEASUREMENTS

Traversing

The bearing of the initial line of the survey being known, there are two ways of carrying it forward in the course of the work. When it is necessary that the correct bearing should be known at all times during the field work, as for example in retracing old lines, it is best to retain the bearing always on the upper plate of the transit, backsighting with the upper plate, giving the last forward course and then turning the upper plate in any new direction required. This method may be used at all times and simplifies the note-taking somewhat, and adds to subsequent clearness. The disadvantages are that the upper plate may move somewhat in transportation between stations, and the vernier must be carefully examined each time a backsight is made. Then, too, it may be inconvenient and is usually unnecessary to figure out the direct solar observation in the field, in which case the entire survey may be completed with either an assumed bearing to commence with, or else by angles, without the use of any bearing whatever. When angles alone are used the angle of the initial line surveyed with the line whose bearing is determined by direct solar observation is read, and when these are identical, as is usually the case, the first line is simply measured to the second station. At the second station the upper plate is set at 0°, the first station bisected by the use of the lower plate and the angle to the next

station read as from left to right, or as the hands of a watch, and noted. When side shots are made, it is well to make horizontal parallel lines above and below the notes taken, so that the line or lines of notes will not be confused with the notes of the main continuous traverse. By this method of carrying forward a survey all errors of instrumental adjustment are eliminated except those entering in the height of standards. Another method of traversing commonly used is to backsight with the upper plate of the transit at 0°, then invert the telescope and turn to the right or left and read the angle turned. While this is probably the method usually employed, it involves a doubling of any errors in adjustment of the transit and a possible error in setting down, each time, the fact that the instrument was turned right or left. On the other hand, the results are more easily reduced to courses than in the method given before, which is always used by the writer.

It is well to read the compass at each station as a precaution against large errors.

Measuring

At the same time that the bearings are being carried forward with the instrument, measurements are being taken. These measurements, as a rule, are to determine the distance traversed, but at times they are also for the purpose of laying out a certain necessary distance. Practically all measurements now made in mineral land surveying are made with long steel tapes, 300 to 700 feet in length, graduated every 5 feet, with each end of the tape graduated to feet and tenths. The method of using long tapes is as follows: The chainman holds the zero of the tape at the station to which the measurement is to be made, and the transit-man pulls the tape, preferably holding it taut

by a pair of parallel pliers, provided with a clamp, just opposite the trunnion of the telescope. The distance is then measured to the nearest 5-foot mark with a pocket tape from the point marked by the clamped parallel pliers. When the nearest 5-foot mark is beyond the transit-man, it saves subtracting the tenths, to which measurements are usually taken, to place the 5-foot mark on the pocket tape over the 5-foot mark on the long tape, and then read as from the 5-foot point ahead of the instrument. Another method for reading the tape is that in which the transit-man holds the 5-foot mark just beyond the distance measured to the transit, and the chainman then holds the tape tightly wherever it happens to come at the forward point. He then reads on the finer graduations the distance from the zero point back to the station, and this is subtracted from the distance read opposite the transit. This method is rarely used, however, as it requires a reliable chainman, and involves possible mistakes in subtracting. It also requires finer graduations on the zero end of the tape.

The writer finds a tape graduated every foot, with the end foot in tenths, a great time-saver. No pocket tape is required, as the tenths may be estimated or marked on a notebook cover. Some surveyors use a notched stick, or even a pencil marked in tenths.

In traversing, the tape may be wound up after each measurement or may be dragged over the ground. The writer prefers the second method, as it saves time. There is, however, greater danger of breaking the tape. Should the tape break it may be temporarily mended by using Alexander's Little Giant Tape Splices, or the surveyor may even carry a piece of solder with a few brass or copper sleeves which he solders on with a candle. The Eureka *Tape Repairer* is a sleeve already prepared with soft solder

and flux, and makes perfect repairs with the heat of a match. As a rule, however, the surveyor proceeds with the longest portion of the broken tape. As the tape breaks most frequently near the zero end, and the chainman has then no handle, it is well to carry an extra pair of parallel pliers for such an emergency.

Stadia measurements cannot be used in patent surveying, but may often be useful in location surveys. If a rod is not available, stadia measurement may be made with a pole. A mark is made on the pole and one of the stadia hairs placed on it. The position of the other stadia wire is then marked, and the distance between the marks measured with a pocket tape. A stadia rod with targets gives long-distance results accurate enough, as a rule, for any mineral land surveying except patent work. The targets are so placed that they correspond to the stadia wires and the distance between them is then measured by pocket tape or taken off the divisions of the rod.

Stadia measurements may be quickly reduced to horizontal distances in the field or office by the use of traverse tables. As the horizontal distance is the stadia reading multiplied by the cosine of the vertical angle squared, by taking the distance from the traverse tables twice we are multiplying the stadia reading by the square of the cosine. For a vertical angle of 12° stadia distance 563 feet in traverse table under 12° and 563 feet we find

Vertical angle.	Stadia measurement.	First reduction or slope distance.
12°	563.0	
	560.0	547.8
	3.0	2.9
		550.7

Vertical angle.	First reduction or slope distance.	Horizontal distance.
12°	550.7	
	550.0	538.00
	0.7	0.68
	Horizontal distance =	538.68

From an ordinary stadia table under the vertical angle of 12° we find .9568 × 563 = 538.68.

Where much stadia work is done it is better to note in the traverse table used the stadia angles corresponding to the angles given in the traverse table. We have found that .9568 is given in the stadia table as the horizontal distance for a stadia measurement of 1 foot and an angle of 12°. For 100 feet the horizontal distance is 95.68. If we look under 17° in the field traverse table we find 95.63 opposite 100. Taking the example above from this column under 17°:

Vertical angle.	Stadia measurement.	Horizontal distance.
17°	563	
	560	535.5
	3	2.87
		538.37

This is near enough for all practical purposes.

If we had taken from a Gurden Table 16° 54′, the real stadia angle for 95.68, we would have a perfect check. If we write 12° 04′ in red for example above 17° in the traverse table we have a stadia table for 12° 04′.

The following table gives the traverse table angles for the corresponding stadia angles. In each case the cosine

of the traverse table angle given is the squared cosine of the stadia angle:

Stadia Angles to Traverse Table — HORIZONTAL

St. an.	Tr. ta.	St. an.	Tr. ta.	St. an.	Tr. ta.	St. an.	Tr. ta.	St. an.	Tr. ta.
12′	15′	6° 22′	9°	12° 36′	17° 45′	18° 44′	26° 15′	25° 10′	35°
20	30	6 34	15′			18 54	30	25 22	15′
36	45	6 44	30	12° 46′	18°	19 6	45	25 32	30
		6 54	45	12 58	15′			25 44	45
44′	1°			13 8	30	19° 16′	27°		
54	15′	7° 4′	10°	13 18	45	19 28	15′	25° 54′	36°
58	30	7 16	15′			19 38	30	26 06	15′
1° 16	45	7 26	30	13° 30′	19°	19 50	45	26 16	30
		7 36	45	13 40	15′			26 28	45
1° 24′	2°			13 52	30	20° 0′	28°		
1 38	15′	7° 48′	11°	14 2	45	20 12	15′	26° 40′	37°
1 44	30	7 58	15′			20 22	30	26 50	15′
2 00	45	8 10	30	14° 12′	20°	20 34	45	27 2	30
		8° 20	45	14 24	15′			27 14	45
2° 8′	3°			14 34	30	20° 44′	29°		
2 16	15′	8° 32′	12°	14 46	45	20 56	15′	27° 24′	38°
2 28	30	8 42	15′			21 6	30	27 36	15′
2 36	45	8 52	30	14° 56′	21°	21 16	45	27 48	30
		9 2	45	15 06	15′			27 58	45
2° 48′	4°			15 18	30	21° 28′	30°		
2 58	15′	9° 12′	13°	15 28	45	21 40	15′	28° 10′	39°
3 10	30	9 24	15′			21 50	30	28 22	15′
3 20	45	9 34	30	15° 40′	22°	22 0	45	28 32	30
		9 44	45	15 50	15′			28 44	45
3° 32′	5°			16 00	30	22 12	31		
3 44	15′	9° 56′	14°	16 12	45	22° 24′	31° 15′	28° 56′	40°
3 54	30	10 6	15′			22 34	30	29 8	15′
4 4	45	10 18	30	16° 22′	23°	22 46	45	29 18	30
		10 28	45	16 34	15′			29 30	45
4° 16′	6°			16 44	30	22° 56′	32°		
4 24	15′	10° 38′	15°	16 56	45	23 8	15′	29° 42′	41°
4 36	30	10 48	15′			23 18	30	29 54	15′
4 46	45	11 0	30	17° 6′	24°	23 30	45	30 4	30
		11 10	45	17 16	15′			30 16	45
4° 58′	7°			17 28	30	23° 40′	33°		
5 8	15′	11° 20′	16°	17 38	45	23 52	15′	30° 28′	42°
5 20	30	11 32	15′			24 04	30	30 38	15′
5 28	45	11 42	30	17° 50′	25°	24 14	45	30 50	30
		11 52	45	18 00	15′			31 00	45
5° 40′	8°			18 10	30	24° 26′	34°		
5 50	15′	12° 4′	17°	18 22	45	24 36	15′	31° 10′	43°
6 2	30	12 16	15′			24 48	30		
6 12	45	12 26	30	18° 32′	26°	25 0	45		

The choosing of proper stations is a very important part of the chainman's duty. A careful chainman can, by good judgment, save much valuable time in selecting stations, which in the first place offer good foresights, and in the second place are suitable for set-ups. In the mountains of the West there is frequently little or no choice in the placing of stations, and the best are often none too good. Stations are usually marked by stakes picked up near the spot. In case it is desired to preserve the traverse stakes, they had best be made of hard wood and carried in sufficient quantity by the party. Opinions differ as to the height of stations. Many, including the writer, prefer a short stake, not showing as a rule over a foot above the surface of the ground. Others prefer a long stake. With the short stake a plumb line will, as a rule, have to be used for both the fore and backsights, but the station is more stable, and is likely to remain in place. With the long stake the use of the plumb may be avoided, as the stake may be seen from the instrument, and this will often save time, but the stakes are very liable to derangement after the lapse of a few days. In many cases large nails may be used for stations, in which case they are simply driven in the ground. They are especially useful in winter when the ground is frozen.

The exact station point on the stake is marked by a nail or tack and, when possible, the measurement is made directly to the point, and both cross wires of the telescope, their intersection, placed on the nail head. In case the nail cannot be seen, the instrument is sighted to a plumb line, the height to which the zero of the tape is held being taken by the horizontal cross wire. In windy weather long plumb bobs filled with mercury give the best results.

When the surveyor has a clear foresight for a longer

distance than the tape will reach, and the country is not too rough, he may set his foresight stakes ahead at a distance apart approximately equal to the stretch of his tape. He may then set up at every other stake, omitting those in between, and make a measurement each way forward and back from each set-up. This will often save considerable time.

The vertical angles for most work need to be read only to the nearest fifteen minutes; that is, they should be within $7\frac{1}{2}$ minutes of correct, and may be read on most transits without the use of the verniers. As a rule in western mineral surveying the horizontal distances must be figured in the field. The best method of figuring is probably by the use of the pocket traverse table, and the traverse table from "Standard Field Tables" is the only suitable one known to the writer.*

The method of using is as follows:

Vertical angle.	Distance.	Horizontal dis. (Lat.)
23°	261.5 = 260.0	239.3
	1.5	1.3
	261.5	240.6

Another method using natural cosines is as follows:

$$\cos 23^\circ = 0.92050.$$

This means that in 100 feet slope measurement the horizontal component is 7.950 feet less. (Simply move the decimal point and subtract each integer from 9, etc.) For all practical purposes the distance to be subtracted from 261.5 feet is $2.61 \times 7.95 = 20.75$; $261.5 - 20.75 = 240.75$. With a table of natural versed sines it is unnecessary to find the cosine and subtract as above. The versed sine for

* "Standard Field Tables" — U. S. General Land Office. Obtained from the Supt. of Documents, Washington, D. C., Price 60 cents, postpaid.

23° is found directly as .07950 for 1 foot. For 100 feet it is 7.950 as above, and is treated in the same way. While this method seems to be more accurate, the correct horizontal distance being 240.71, it is probably not so in most cases; in fact, as it is extremely difficult to pull the tape perfectly tight, there is a tendency to set down a measurement which is too large.

In many cases a certain definite distance must be laid out with the tape on a hillside, as, for example, in locating the end of a lode claim or in setting corners from the center line. We may find, for example, that to complete the 1,500 feet of a lode claim we have 294.5 feet yet to go. We find the angle of slope is 15° and this apparently continues for the distance required. From the traverse table we find that the nearest horizontal (latitude) to 294.5 given in the column for 15° is 289.8, which equals 300 feet on the slope. This leaves a horizontal distance over of 4.7 which in turn equals 4.9 on the slope. The distance to be laid off is therefore 304.9 feet on the slope.

Example:

Ver. Angle.	Horizontal.	Slope.
15°	289.8	= 300.0
	4.7	= 4.9
	294.5	= 304.9

As the versed sine was used for calculating the horizontal distance, the secant or external secant may be used for finding the slope distance.

$$\text{exsecant } 15^\circ = .0353 \times 294.5 = 10.39$$
$$294.50 + 10.39 = 304.89.$$

To return to laying out distances, it will often be found, especially by one who is not good at estimating distances, that the trial angle of slope is too small or too great, as *the case may be*, and the horizontal wire of the instrument

either hits the ground or comes too high above the station. In that case the only thing to do is to try a new angle until everything corresponds.

The final distance to be measured is marked on the tape by the parallel pliers and the instrument sighted to the zero of the tape, held at the proper height on a stake or by plumb bob.

The surveyor will frequently meet obstacles which require offsets, a subject which is well handled, as a rule, in the standard books on surveying. The usual offset is at right angles far enough to avoid the obstacle. A convenient offset is to turn off say 60° to the right, measure any suitable distance, then run the same distance with 60° turned to the left. In this way the distance required is exactly equal to the distance measured on the offset, as we are dealing with an equilateral triangle. (See Fig. 16.)

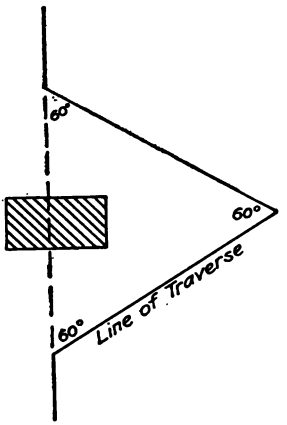


Fig. 16

Sometimes a long traverse has to be made to get around an obstacle, and sometimes the measurement has to be made by triangulation either to the point which it is desired to reach or to some point near. Triangulation methods are, of course, simple, and are exhaustively treated in text-books. Traverses, that is, measured traverses to find a missing course, are not, as a rule, so well handled in the text-books, and it is sometimes necessary to do all the figuring in the field. In figuring a traverse, the first thing necessary to do is to get the traverse into a record of *courses and distances*. When the true bearing is

carried throughout the survey nothing has to be done but to put down the bearings and the horizontal measurements, and figure the latitudes and departures. When assumed bearings have been used, they must be corrected. In case the inverting right or left method has been used from the initial bearing, the succeeding courses may be easily figured. In case the instrument is read as though turned from left to right, that is, clockwise the following rule simplifies the calculation of bearings.

Rule: Take angle right from backsight. If less than 180°, add 180°; if greater than 180°, subtract 180° from it. Add results to former course from north, or azimuth. If required, subtract 360°. The result is the azimuth from north.

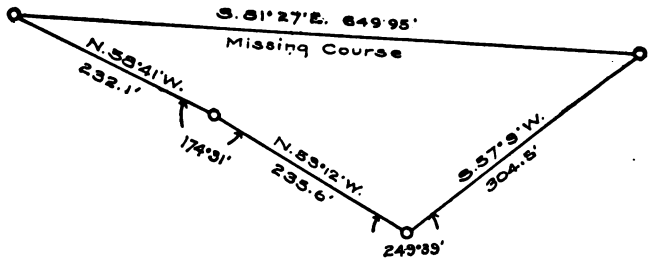


Fig. 17

Example: (Fig. 17.)

	S. 57° 9' W.	
	180°	249° 39'
		180°
Azimuth =	237° 9'	
	69° 39'	69° 39'

Azimuth first course = 306° 48' = N. 53° 12' W.

	174° 31′
	180°
354° 31′	354° 31′
661° 19′	
360°	

Azimuth second course = 301° 19′ = N. 58° 41′ W.

The courses and horizontal distances at hand, the latitudes and departures are figured, preferably with a traverse table. Among the many traverse tables, Gurden's is the most rapid. In using the Gurden's tables to facilitate picking out the figures, a triangle, preferably a transparent one, or even a card may be marked and so spaced that, one mark being placed under the latitude figure, the other mark falls of itself under the figure for the departure.

A card marked as in Fig. 18 is an even greater help in

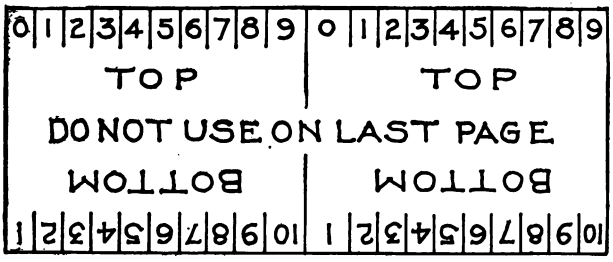


Fig. 18

rapid calculation. In using the card, the figure 4 on the left side of the card is placed under the cosine of 4, 14, 24, etc., and the right hand 4 falls under the sine of 4, 14, 24, etc.

An example of a short traverse is given below, with the missing course calculated, and many similar cases will be given later. Examples of latitudes and departures figured with the *Gurden's table* are also given.

Neat and systematic work may be done by the use of printed blanks, each of which is afterwards filed away, as will be described later.

		Cos. latitude.	Sin. Departure.
57° 9′			
	300.0	162.73	252.03
	4.5	2.44	3.78
		165.17	255.81
53° 12′			
	230.0	137.77	184.16
	5.6	3.35	4.48
		141.12	188.64
58° 41′			
	230.0	119.54	196.49
	2.1	1.09	1.79
		120.63	198.28

Station.	Course.	Distance.	N. lat.	S. lat.	E. dep.	W. dep.
———	S. 57° 9′ W.	304.5	.....	165.17	.....	255.81
———	N. 53° 12′ W.	235.6	141.12	.....	.....	188.64
———	N. 58° 41′ W.	232.1	120.63	.....	.....	198.28
			261.75			642.73
			165.17			
			96.58			

$$\log 96.58 = 1.984887$$
$$\log 642.73 = 2.808028$$
$$9.176859 = \log \cot 81° 27'$$

$$\log 642.73 = 2.808028$$
$$\log \sin 81° 27' = 9.995146$$
$$2.812882 = \log 649.95$$

Missing course = S. 81° 27′ E. 649.95

Note. — It is well to remember to take the log of the larger number, whether latitude or departure, and divide it by the larger log, whether sine or cosine, of the angle found.

CHAPTER IV

LOCATION SURVEYS

Lode Location

About the simplest survey that the western surveyor is called on to make is that of a lode location. It is, however, somewhat complicated by the fact that, as a rule, he is assisted in the work by the claimant himself, and thus often lacks an efficient assistant.

Usually the survey is begun at the discovery point, which may be a shaft, cut, adit, or even a point in the tunnel or other underground workings. We will begin with the survey of a straight claim as in Fig. 19. (See

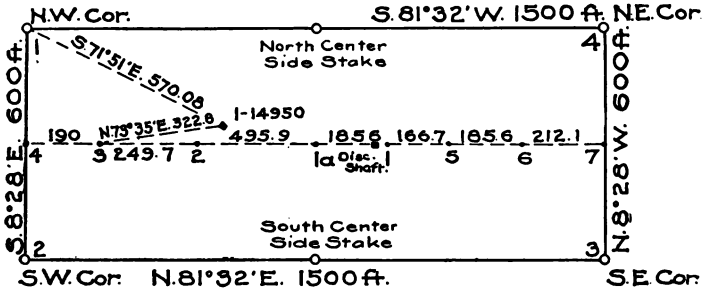


Fig. 19

also page of notebook.) The first set-up, in this particular case, is just 30 feet from the center of the discovery shaft. After the direction of the center line has been determined — and, in unimportant work, this may often be

GOOD SAMARITAN LODE, GOLD DIRT MINING DISTRICT.
Monday, May 29, 1920
RUDOLF GALE

At station	B. S. station.	Angle. A. ver.	Angle. B. ver.	Vert. angle	Slope dist.	Hor. dist.	Mag. course.	True course.	To station.	Remarks.
1	...	.....	.....	2°	496.2	495.9	S. 81° W.	S. 81° 32′ W.	2	No. 1 = 30 E. of dis. shaft.
2	1	.....	.....	5 30′	250.9	249.7	S. 81 30′ W.	S. 81 32 W.	3	
3	2	.....	.....	0	190.0	190.0	S. 81 30 W.	S. 81 32 W.	4	End line.
1	...	.....	.....	0	185.6	185.6	.....	S. 81 32 W.	1a	Center side stakes.
1	...	.....	.....	3 30	167.1	166.7	N. 81 15 E.	N. 81 32 E.	5	
5	1	.....	.....	10	188.5	185.6	N. 81 30 E.	N. 81 32 E.	6	
6	5	.....	.....	8	214.1	212.1	N. 81 15 E.	N. 81 32 E.	7	End line.
3	2	352° 3′	172° 3′	6 30	325.0	322.8	N. 74 E.	N. 73 35 E.	1–14950	Columbus lode.

2° 490.0 = 489.7
6.2 = 6.2
496.2 = 495.9

3° 30′ 160.0 = 159.7
7.1 = 7.0
167.1 = 166.7

8° 210.0 = 208.0
4.1 = 4.1

5° 30′ 250.0 = 248.8
0.9 = 0.9
250.9 = 249.7

10° 180.0 = 177.3
8.5 = 8.3
188.5 = 185.6

495.9 1500.0
249.7 1287.9
190.0
166.7 212.1
185.6
1287.9

Dis. 16th March, 1920.

done with the magnetic needle — a measurement is made as before explained under measurements, to station No. 2. It will save the transit-man a set-up if a measurement is taken at the same time to No. 5. In a rough country, however, this will give the chainman more work. From station No. 2 the line is extended through No. 3 to No. 4, at which point the claimant desires to end his claim. A right angle is therefore turned off, and the stakes set, we will say, 300 feet on each side of the center line. These stakes, the best obtainable, are marked Cor. No. 1, N. W. Cor., Good Samaritan Lode; and Cor. No. 2, S. W. Cor., Good Samaritan Lode, respectively. From No. 3 a tie is made to Cor. No. 1, Sur. No. 14950 Columbus Lode, as shown in the notes. As we have now measured 935.6 feet, we know that we have passed the point for setting center side stakes, so we return to No. 1 and measure back 185.6 feet to No. 1*a*, whence the center side stakes are set at right angles to the center line. They are marked North and South Center Side Stakes, Good Samaritan Lode, respectively. Of course, it frequently happens that the position of the center side stakes is known in advance, and in this case a measurement would have been made in the beginning to No. 1*a*. In this case No. 1*a* would have been called No. 2 and the next sight might have been made to No. 3, etc.; but in the case of the Good Samaritan Lode the center side stakes could not be placed till the claimant had decided where the claim was to end in its westerly course. We now extend the line through No. 5 and No. 6 and here, knowing that the survey can be completed with another sight, the previous measurements are reduced to horizontals, the total subtracted from 1,500 and the result laid out. Corners No. 3 and No. 4 are then set as for the westerly end. *If a tie* has not been made to a patent cor-

ner, or some other proper monument, as above, the instrument is set up at some corner of the claim, preferably Cor. No. 1, and bearings to two or more mountain peaks or other permanent points taken and recorded. The surveyor then makes sure that he has the name of the lode, a description of the discovery, whether shaft, cut, etc., the correct name of the locators, the name of the mining district and the date. At his office the surveyor figures the tie to the patented claim as given below, writes out the certificate, usually signs it for the claimant, and sends it for record to the county recorder. Several styles of blank forms for location certificates are sold by different publishers, but they are all essentially the same. The location certificate of above is as follows:

STATE OF COLORADO, }
County of Teller, } ss.

Know All Men by These Presents: That **Rudolf Gale,** the undersigned, has this **29th day of May, 1920,** located and claimed, and by these presents does locate and claim by right of discovery and location, in compliance with the Mining Acts of Congress, approved May 10, 1872, and all subsequent acts, and with local customs, laws and regulations, **1,500** linear feet and horizontal measurement on the Good Samaritan lode, vein, ledge or deposit, along the vein thereof, with all its dips, angles and variations as allowed by law, together with 300 feet on **each** side of the middle of said vein at the surface, so far as can be determined from present developments; and all veins, lodes, ledges, or deposits and surface ground within the lines of said claim **594.4** feet running **N. 81° 32′ E.** from center of discovery **shaft** and **905.6** feet running **S. 81° 32′ W.** from *center of discovery* **shaft,** said discovery **shaft** being situ-

ate upon said lode, vein, ledge or deposit, and within the lines of said claim in **Gold Dirt** Mining District, County of **Teller,** and State of Colorado, described by metes and bounds as follows, to-wit:

Beginning at Cor. No. 1, **whence Cor. No. 1, Sur. No. 14950, Columbus lode, bears S. 71° 51′ E. 570.05 feet, thence S. 8° 28′ E. 600 feet to Cor. No. 2, thence N. 81° 32′ E. 750 feet to south center side stake, thence N. 81° 32′ E. 750 feet to Cor. No. 3, thence N. 8° 28′ W. 600 feet to Cor. No. 4, thence S. 81° 32′ W. 750 feet to north center side stake, thence S. 81° 32′ W. 750 feet to Cor. No. 1, the place of beginning.**

Said lode was discovered on the **16th day of March,** A.D. **1920.**

Date of location, **May 29, A.D. 1920.**

Date of certificate, **May 29, A.D. 1920.**

RUDOLF GALE. (Seal.)

It is not necessary to mention the center side stakes in the description. Should several claimants desire to be recorded as possessing unequal shares, the names may be arranged as follows, at the bottom:

J. P. Smith, ½ interest.
L. S. Weaver, ¼ interest.
L. J. Walter, ¼ interest.

For a company, the name may simply be placed at the bottom, with or without the addition of the name of an agent or attorney in fact.

Other examples of location certificates will be given under field notes of patent survey.

The above simple straight location may be varied in many ways. The end lines may not be at right angles to

the center, but made to fit some other claim; in this case the end line is longer than the width of the claim, and is figured in the same way as the end line of an angular claim given later. In order to avoid conflicts, the claim is frequently made narrower than the legal width, sometimes on one side of the center, sometimes on both sides, and the side lines may even be broken lines. In this latter case they are figured as examples of mill sites or intersections of patents, etc., which will be given later. There is probably no legal objection to having the end line even longer than the side line, as is the case in Fig. 20. In this example, were a mistake made and the vein placed as shown in the figure, the claimant would get over 3,000 feet of vein in one location, provided the vein was

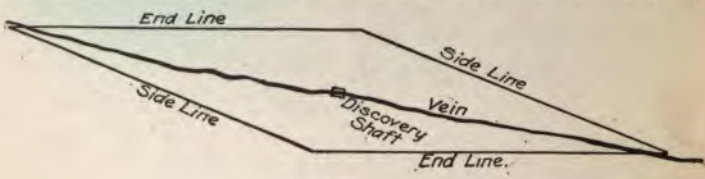


Fig. 20

perpendicular, so as not to require extralateral rights. At the time of issuance of patent, of course, this could not be known, as the vein is required, as far as known, to be not more than 150 or 300 feet from either side line, according to the district.

Angular Claims

In the case of angular claims the conditions given above are more or less complicated. The simplest angular claim is one whose one angle is at or near the discovery and therefore known in advance, or at least before either end line is laid out. This is easily surveyed, as follows: See

Fig. 21, the angle *a* being determined as 40°. The angle *b* is equal to 140°. In placing the angle stakes the angle *b* is bisected, that is, 70° is turned from either the foresight or the backsight on the southerly side, or 110° turned from

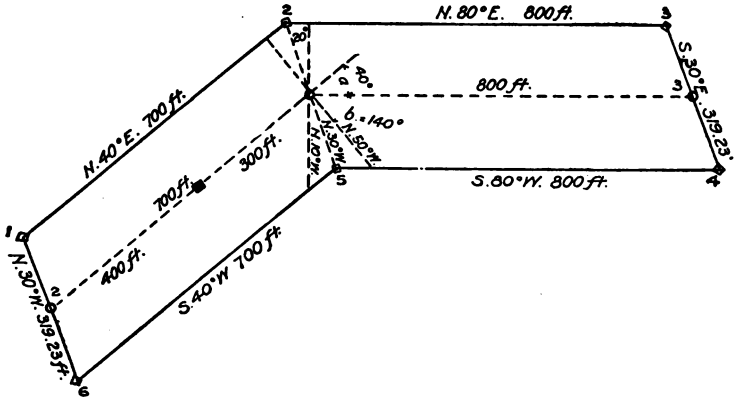


Fig. 21

either the foresight or backsight on the northerly side. The bisecting line is therefore 20° in each case from a line at right angles to the lines 1 — 2 and 1 — 3. The direction of this line is seen at once to be in the figure above, S. 30° E. (90° − 80° = 10° + 20° = S. 30° E. 90° − 40° = 50° − 20° = S. 30° E.) As one-half of this line is the hypothenuse of a right triangle whose base is 150 feet (or, as the case may be, 75 or 300 feet), and whose angle *A* is 20°, its length is found from a traverse table, or table of natural secants, to be:

	Lat.		Distance or nat. secant.	
20°	141.0	=	150.0	20° = 1.0641
	9.0	=	9.6	300
	150.0	=	159.6	2)319.23 end line
				159.61

which is the true distance from No. 1 to the angle corner S. 30° E., and also, of course, in the other direction N. 30° W. These lines in turn must be corrected for slope of hill. The end lines are then placed parallel to the line of the angle stakes, and the same length. The stakes are marked as given under straight lode locations, except the angle stakes are marked Cor. No. 2, and Cor. No. 5 North and South angle stakes, respectively. As the end lines and angle stake line are all parallel, the opposite side lines are the same length; therefore no figuring or checking up is required in the office and the location certificate may be written out at once. This certificate is exactly the same as in the case of a straight claim, except that in the best work, when the discovery shaft is not exactly at the angle, additional description is required; for example, in Fig. 20 it would be described " " " " claims 400 feet running S. 40° W. from center of discovery shaft and 300 feet running N. 40° E., thence 800 feet running N. 80° E., etc.

In surveying an angular claim where the angle is not known when the first end line is reached, or when there are two or more angles in the claim, this first end line is usually put in at right angles to the center line. In the case of a claim having only one angle, the setting of the end line may often be postponed till the angle of the center line is determined. When the end line is set at right angles one or more sets of angle stakes are placed on lines bisecting the angles, as given above; but these lines are not parallel to the end lines, nor are they necessarily parallel to each other. As the end lines of the claim must be parallel to each other, this requires that the end line for No. 4 be turned from a line at right angles to its center line over an angle equal to the algebraic sum of all the angles entering into the broken center line of the claim, or from the

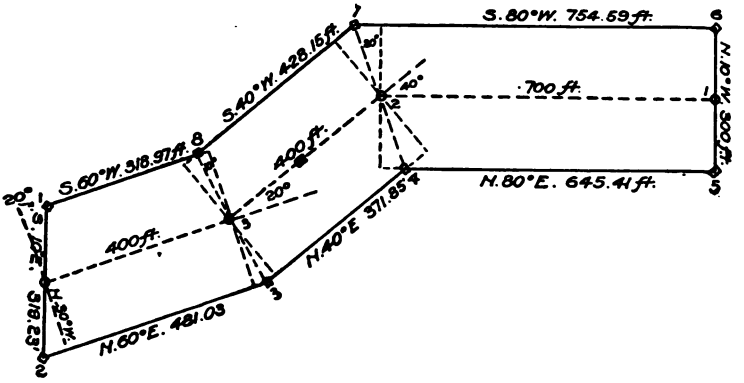


Fig. 22

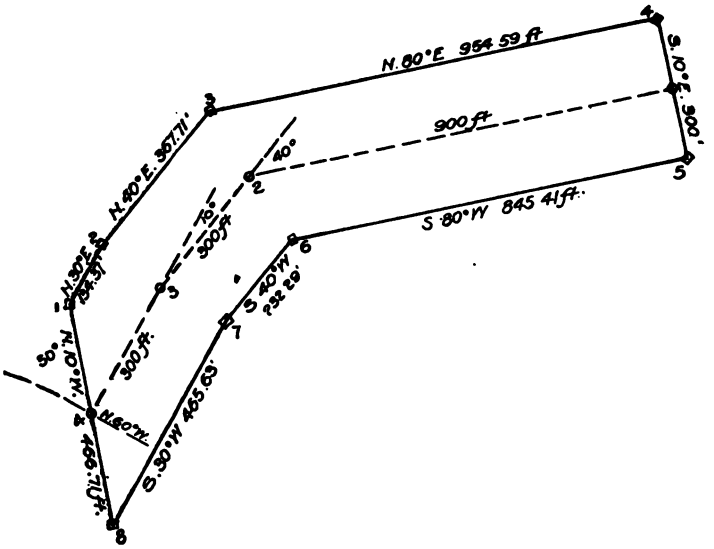


Fig. 23

backsight on the center line over the complement of this algebraic sum. This is shown in the two figures above, Fig. 22 and Fig. 23, to be 20° and 50°, respectively, as the

deviation from a straight center line is always to the right or first to the right and then to the left; right figure as plus and left as minus.

The end line angle is thus the angle caused by the total change of direction of the center line of the claims from its course No. 1–No. 2 to its course No. 3–No. 4.

The length of the end line is figured as the hypothenuse of a right triangle whose base is 300 feet (or 150 or 600, as the case may be), and whose angle *A* is the angle turned from a line at right angles to the center line at that point. This in turn is corrected for the slope of the hill. While it is no more difficult to stake out this kind of an angular claim in the field than in the case of the angular claim first cited, the office work is more involved. The side lines opposite to each other are not of equal length, as in the case of the angular claim first cited. The length in each case is found by adding and subtracting on opposite sides the perpendiculars or departures of the various triangles used and figured in setting the stakes, to the lengths actually measured on the center line of the claim. For the angular claim given in Fig. 22, the most easterly angle is first figured, 150 feet multiplied by the tangent of 20° gives 54.59, which is added for the northerly side lines and subtracted for the southerly lines, that is, added to exterior angles and subtracted from interior ones, to and from the distances measured on 1–2 and 2–3 on the center line. For the next angle west 26.44, the tangent of 10° multiplied by 150 feet, is subtracted for the northerly side lines, and added for the southerly side lines, from and to 2–3 and 3–4 on the center line, remembering that 54.59 feet have already been subtracted from or added to 2–3. Finally 54.59, tangent 20° multiplied by 150, is subtracted for the northerly side line and added for the southerly side line to and from

3–4, from and to which 26.44 feet have already been subtracted and added. In Fig. 23 the same method is pursued. On the northerly side line the tangents are added until the end line is reached, then subtracted from the center line distances, while for the southerly side line the tangents are subtracted until the end line is reached and then added. To be sure that the work has been done correctly and that the boundary lines close, a traverse is made as in the following examples. While the traverse may be made in the usual way, the labor is greatly decreased by subtracting the length of the corresponding side lines and end lines from each other, using the direction in each case of the longer line. We thus find latitudes and departures for only half the courses and for smaller numbers. The closing of the traverse round the claim proves the correctness of the previous work.

Example:

	Course.	Distance.	N. lat.	S. lat.	E. dep.	W. dep.
.....	S. 10° E.	19.23	.....	18.93	3.32	.....
Fig. 22..	N. 60 E.	162.06	81.05	.....	140.32	.....
.....	S. 40 W.	56.30	.....	43.11	.....	36.18
.....	S. 80 W.	109.18	.....	18.95	.....	107.52
			81.05	80.99	143.64	143.70

	Course.	Distance.	N. lat.	S. lat.	E. dep.	W. dep.
.....	N. 10° W.	166.71	164.16	.....	.....	28.94
Fig. 23..	S. 30 W.	331.26	.....	286.86	.....	165.63
.....	N. 40 E.	135.42	103.72	.....	87.04	.....
.....	N. 80 E.	109.18	18.95	.....	107.52	.....
			286.83	286.86	194.56	194.57

	Course.	Distance.	N. lat.	S. lat.	E. dep.	W. dep.
.....	N. 15° E.	25.72	24.85	.....	6.65	.....
Fig. 25..	S. 82 W.	60.82	.....	8.46	.....	60.22
.....	S. 73 E.	56.04	.....	16.38	53.58	.....
			24.85	24.84	60.23	60.22

Another method of checking an angular claim, when one end line is at right angles to the center line, is to turn the claim so that the end line is described as north and south. The adjacent side lines at right angles are then east and west, and only the latitudes and departures of the differences in distances of the other lines have to be calculated. Taking the claim in Fig. 24*a*, we place the end lines North and South as in Fig. 24*b*. The latitude and departure of the distance N. 33° W. 62.88 feet, changed to N. 68° W. 62.88, is the only latitude and departure to be calculated.

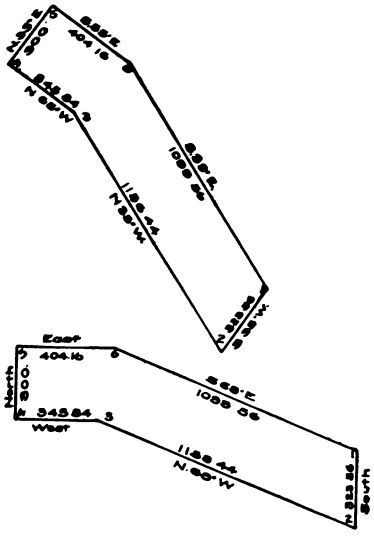


Fig. 24 *a* and *b*

Course.	Distance.	N. lat.	S. lat.	E. dep.	W. dep.
South.....	23.56	.....	23.56	.....	.....
N. 68° W.....	62.88	23.56	.....	.....	58.31
East.....	58.32	.....	.....	58.32	.....
		23.56	23.56	58.32	58.31

It frequently happens that in case of angular claims the end lines must be made to fit prior claims. In this case the calculations for the amounts to be added to the length of the center line must be made at each end of the claim as well as at the angles, and the amounts to be added and the lengths of the line will vary according to the angle at which the latter are set. (See Fig. 25.) Angular claims

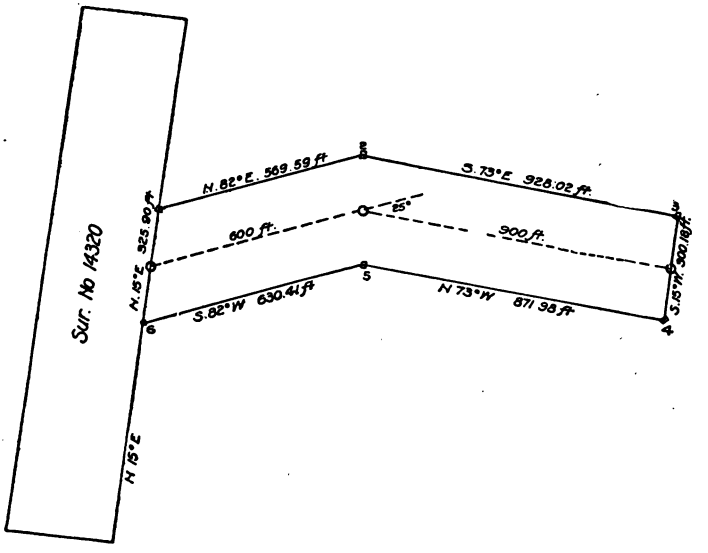


Fig. 25

may also be narrowed down and located with irregular side lines, but the figuring of these variations is only a form of the figuring done in such work as patent intersections, treated later on.

In all lode locations, the setting of end lines is of great importance. The end lines should be placed as a rule as nearly as possible at right angles to the strike of the vein, while the *location survey* covers the apex.

The dip of the lode and the extralateral rights desired should always be kept in mind by the surveyor. Thus, in Fig. 25, the arrangement of end lines, placed so as to avoid conflict with the prior location, may not be the best, or may be extremely bad, when the question of extralateral rights is considered. It is therefore often best not to survey to avoid a conflict, but to make the best possible arrangement of end lines to cover the ground desired.

Relocation and Amended Certificates

"Distinction Between Relocation and Amended Certificate. In strictness there is a relocation only when some change is made upon the ground, as by changing length, width or boundaries, perhaps also when overlapping abandoned ground is taken. The certificate filed to show such change is a relocation certificate. But if error is in the papers only, as by a misleading or too vague description, there is no relocation, but only the filing of an amended location certificate. But the terms are not always used with exactness even by the legal profession, all such papers as well as acts being called relocations or relocation certificates, and a misuse of the term is not generally material. — Cheeseman *vs.* Shreeve, 40 Fed. 789." — Morrison's "Mining Rights," p. 109, 10th ed.

It frequently happens, especially just before surveying for patent, that the descriptions of claims are found to be defective in some respect, and in this case an amended description is filed, and no change is made upon the ground. More often, however, the stakes on the ground are changed somewhat, and the owner takes advantage of a resurvey to take in some abandoned ground, or to alter the lines of
 claim slightly one way or the other from the original
ation. He may even make radical changes in direction

of lines and extent of territory embraced. In this event there is no change in the method of survey from the procedure in the case of the original location, but the certificates are worded to suit the case. Of the two examples of amended and relocation certificates which follow, the first is rarely used, as the second covers almost every possible case. In some cases it is well to state the cause for amending, as, for example, that it is to correct the spelling of the name of the claim or location. This assumes importance when it is desirable to impress suspicious neighbors with the fact that no change has been made in the boundaries of a claim, and that the amendment is made simply to perfect the description.

In the case of a second amendment we add to "This being the same lode, * * *", "and again located on the 18th day of April, 1905, and recorded on the 31st day of April, 1905, in book 160, page 352, in the office of the recorder of Clear Creek county."

Additional and Amended Location Certificate — Law of 1889.

STATE OF COLORADO, }
County of Clear Creek, } ss.

Know All Men by These Presents, That **The Treasure Vault Gold Mining Company** has, this **18th** day of **April,** 1905, amended, located and claimed, and by these presents does amend, locate and claim, by right of the original discovery and this additional and amended location certificate, in compliance with the Mining Acts of Congress, approved May 10, 1872, and all subsequent acts, and with Section 2409 of the General Statutes of Colorado, and with local customs, laws and regulations, **717.2** linear feet and horizontal measurement on the **Boreas** lode, vein, ledge —

deposit, along the vein thereof, with all its dips, angles and variations, as allowed by law, together with 75 feet on each side of the middle of said vein at the surface, so far as can be determined from present developments, and all veins, lodes, ledges or deposits and surface ground within the lines of said claim, 10 feet running northeasterly from center of discovery shaft and 707.2 feet running southwesterly from center of discovery shaft, said discovery shaft being situate upon said lode, vein, ledge or deposit, and within the lines of said claim, in Idaho Mining District, County of Clear Creek and State of Colorado, described by metes and bounds as follows, to-wit:

Beginning at Corner No. 1, thence S. 14° 15′ E. 152.48 ft. to Cor. No. 2; thence S. 65° 24′ W. 377.33 ft. to Cor. No. 3; thence S. 89° 2′ W. 339.79 ft. to Cor. No. 4; thence N. 14° 15′ W. 154.12 ft. to Cor. No. 5; thence N. 89° 2′ E. 343.81 ft. to Cor. No. 6; thence N. 65° 24′ E. 373.47 ft. to Cor. No. 1, the place of beginning.

From Cor. No. 1, Cor. No. 3, Sur. No. 12276, Bessie lode bears N. 14° 15′ W. 7.66 ft.

This being the same lode originally located on the 21st day of February, 1901, and recorded on the 2nd day of March, 1901, in book 147, page 319, in the office of the Recorder of Clear Creek County. This further additional and amended certificate of location is made without a waiver of any previously acquired rights, but for the purpose of correcting any errors in the original location, description or record, and making more specific the boundaries and description of said lode as originally located upon the ground.

THE TREASURE VAULT GOLD MINING CO.

[Seal.] By J. P. Little, Agent.

Said lode was discovered the **15th day of February,** A.D. **1901.**

Date of additional and amended certificate, **April 18th,** A.D. **1905.**

Additional and Amended Location Certificate — Law of 1889.

STATE OF COLORADO, }
County of Clear Creek, } ss.

Know All Men by These Presents, That **The Treasure Vault Gold Mining Company** has, this **18th day of April,** 1905, amended, located and claimed, and by these presents does amend, locate and claim, by right of the original discovery and this additional and amended location certificate, in compliance with the Mining Acts of Congress, approved May 10, 1872, and all subsequent acts, and with Section 2409 of the General Statutes of Colorado, and with local customs, laws and regulations, **1014.2** linear feet and horizontal measurement on the **Arc Light** lode, vein, ledge or deposit, along the vein thereof, with all its dips, angles and variations, as allowed by law, together with **75 feet on each** side of the middle of said vein at the surface, so far as can be determined from present developments, and all veins, lodes, ledges or deposits and surface ground within the lines of said claim, **21** feet running **N. 61° 37′ E.** from **face** of discovery **cut** and **993.2** feet running **S. 61° 37′ W.** from **face** of discovery **cut,** said discovery **cut** being situate upon said lode, vein, ledge or deposit, and within the lines of said claim, in **Idaho** Mining District, County of **Clear Creek** and State of Colorado, described by metes and bounds as follows, to-wit:

Beginning at Corner No. 1, thence S. 28° 23′ E. 150 ft. to Cor. No. 2; thence S. 61° 37′ W. 1014.2 ft. to Cor. No

thence N. 28° 23′ W. 150 ft. to Cor. No. 4; thence N. 61° 37′ E. 1014.2 ft. to Cor. No. 1, the place of beginning.

From Cor. No. 1, Chief Mt. bears S. 5° W. and a prominent peak bears S. 30° W.

This being the same lode originally located on the **21st** day of **February, 1901,** and recorded on the **2nd** day of **March, 1901,** in book **147,** page **320,** in the office of the Recorder of **Clear Creek** County. This further additional and amended certificate of location is made without a waiver of any previously acquired rights, but for the purpose of correcting any errors in the original location, description or record, and of taking in and acquiring all forfeited or abandoned, overlapping ground, and of taking in any part of any overlapping claim which has been abandoned, and of securing all the benefits of said Section 2409 of the General Statutes of Colorado.

THE TREASURE VAULT GOLD MINING CO.
[Seal.] By J. P. Little, Agent.

Said lode was discovered the **15th day of February,** A.D. **1901.**

Date of additional and amended certificate, **April 18th,** A.D. **1905.**

Mill Sites and Placers

Mill sites and placers are, for the most part, on streams. Placers are required by the General Land Office to be taken up by legal subdivisions when on surveyed lands. When the land is not surveyed, as is often the case with mineral lands, placers should be surveyed as regularly as possible.

At present the General Land Office requires all placer claims on unsurveyed lands to be laid off as if the land were properly surveyed. In other words, the surveyor is prac-

tically required to survey the whole country, or as much of it as is necessary to establish the legal subdivisions of the placer required. When the nearest surveyed tract is far distant, the department would probably permit a placer to be surveyed with east, west, north and south boundaries.

As a rule the surveyor will lay out a mill site in rectangular form for simplicity, and the following table, taken from Morrison, will often be useful:

"Area in Feet or Acres. — By the following table the number of feet necessary to include any desired number of acres when in the shape of a square or parallelogram may be ascertained:

Claim	660 × 330	feet	contains	5	acres.
"	500 × 500	"	"	5.73	"
"	660 × 660	"	"	10	"
"	1320 × 660	"	"	20	"
"	800 × 1089	"	"	20	"
"	933⅓ × 933⅓	"	"	20	"
"	1320 × 1320	"	"	40	"
"	2640 × 2640	"	"	160	"

43,560 square feet = 1 acre. A square 208.71 feet in length and width = 1 acre." — Morrison's "Mining Rights," p. 185, 10th ed.

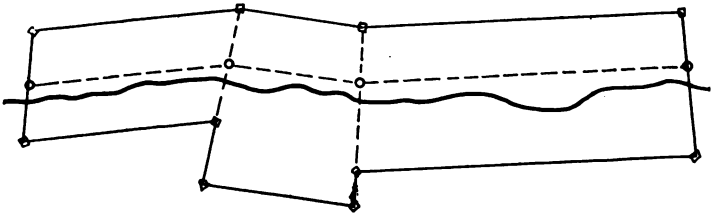


Fig. 26

It may happen that the survey must follow the meandering of a stream, and in this case the rules for angu

claims may often apply. Even when the claim must be widened or narrowed the same rules hold, each portion being figured separately as in Fig. 26, the whole forming 5 acres or less in the case of a mill site, and 20 acres or less for each claimant in a placer. The end lines, if they may be so called, need not, of course, be parallel, as in the case of lode locations. In case it is desired to include all possible ground between two claims, *A* and *B*, Fig. 27, the

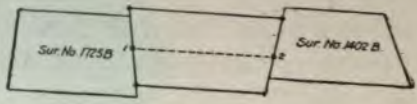


Fig. 27

center line 1–2 is measured and the width of claim then laid out, giving 217,800 square feet (5 acres) when multiplied by the length of 1–2. The end lines are figured as in angular claims.

Fig. 28

If the center line of the mill site cannot be used, extend the lines of the bounding claims so as to form a triangle as in Fig. 28. With the line 1–4 as a base, calculate the sides and area of the triangle so formed. From the area subtract 5 acres = 217,800 sq. ft. We now have two similar triangles. The squares of the homologous sides are to each other as the areas.

$$\textit{Area triangle } 1\text{–}0\text{–}4 = \frac{600^2 \sin 95^\circ \sin 60^\circ}{\sin 25^\circ} = 8.435 \text{ acres.}$$

Area mill site 1–2–3–4 = 5 acres.
Area triangle 2–0–3 = 8.435 − 5 = 3.435 acres.
Line 2–3 = $600^2 : 8.435 :: x^2 : 3.435 = 382.9 = x$ or line 2–3.
Draw line N–3 parallel to line 1–2.
Line N–4 = 600 − 382.9 = 217.1.
Solve oblique triangle N–3–4.
Line N–3 = 444.88.
Line 1–2 = line N–3 = 444.88.
Line 3–4 = 511.75.

If it is not desired to have the side lines parallel as in Fig. 29, it is necessary to find the area of the triangle 1–2–3

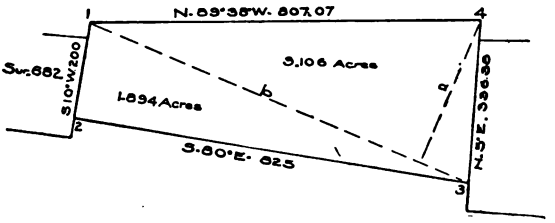


Fig. 29

and the side b. Suppose this area to be 1.894 acres; subtracting this from 5 acres, we have 3.106 acres as the area of the triangle 1–3–4. Find the altitude a, which, multiplied by b and divided by 2, will give 3.106 acres. From this altitude calculate 3–4 and 1–4.

It sometimes happens that very irregular tracts must be laid out, and there is no escape from more or less extensive figuring to get the correct boundaries for the number of acres to be included. It will then be necessary to divide the area under consideration into rectangles or triangles, or both, or calculate the area by double meridian distances. The method of surveying will also vary according to the circumstances of the case. It may be possible to survey

from a center line, as in Fig. 30, or, in the case of large tracts, it may be necessary to run the exterior boundaries. Ties should be made as for all lode claims.

Fig. 30

In any case, except when rectangular tracts are surveyed, the final description must be carefully checked by traverse as in the case of the angular claims, to make sure of a closure, and the area figured by double meridian distances.

Double Meridian Distances

The traverse is begun with the most easterly or westerly station (Fig. 31). Double Meridian Distances = D. M. D., of preceding course plus the departure of that course, plus

Fig. 31

the departure of the course itself. The first and last D. M. D. are the same as the respective departures. The latitudes are arranged plus and minus North and South respectively, multiplied by their D. M. D. as above. The

Century Mill Site

Course.	Distance.	N.	S.	E.	W.	D. M. D.	+	−	+ Areas.	− Areas.
S. 79° 5′ E.....	300.0	.....	56.81	294.56	.....	294.56	.....	56.81	.....	16733.9
North.....	148.0	148.0	.....	.....	.....	589.12	148.0	.....	87189.8	.....
S. 72° 13′ E.....	210.0	.....	64.13	199.96	.....	789.08	.....	64.13	.....	50603.7
South.....	80.0	.....	80.00	.....	.....	989.04	.....	80.0	.....	79123.2
S. 72° 2′ E.....	474.5	.....	146.35	451.33	.....	1440.37	.....	146.35	.....	210798.0
South.....	88.0	.....	88.00	.....	.....	1891.70	.....	88.0	.....	166470.0
N. 88° 32′ W.....	946.18	24.26	.....	.....	945.85	945.85	24.26	.....	22946.3	.....
North.....	263.0	263.0	.....	.....	.....	.....	263.0	.....	.....	.....
		435.26	435.29	945.85	945.85				110136.1	523728.8
										110136.1
										2)413592.7
										206796.3

4.747 acres.

log 206796.3 = 5.3155427
colog 43560.0 = 5.3609121
log 4.747 = 0.6764548

plus and minus areas resulting are then added and the lesser subtracted from the greater and the result divided by 2. The result is the area in square feet.

Care must be taken, in the case of a mill site that is cut into tracts by other claims, to locate the mill site as one unit not including more than 5 acres, and, during the patent surveying, cut into tracts.

Location Certificate — Mill Site

STATE OF COLORADO, }
County of Clear Creek, } ss.

To All Whom These Presents May Concern:

Know ye that I, **John T. McDonald, of Idaho Springs, Colorado,** do hereby declare and publish as legal notice to all the world that I have a valid right to the occupation, possession and enjoyment of all and singular that tract or parcel of land not exceeding five acres, situate, lying and being in **Montana** Mining District, in the County of **Clear Creek,** in the State of Colorado, bounded and described as follows, to-wit:

The **CENTURY** Mill Site, beginning at Corner No. 1, **whence Cor. No. 6, Sur. No. 1465, Cohos Mill Site, bears N. 16° 42′ W. 27.6 ft.; thence S. 79° 5′ E. 300 ft. to Cor. No. 2; thence N. 148 ft. to Cor. No. 3; thence S. 72° 13′ E. 210 ft. to Cor. No. 4; thence S. 80 ft. to Cor. No. 5; thence S. 72° 2′ E. 474.5 ft. to Cor. No. 6; thence S. 88 ft. to Cor. No. 7; thence N. 88° 32′ W. 946.18 ft. to Cor. No. 8; thence N. 263 ft. to Cor. No. 1, the place of beginning.**

Containing 4.747 acres, together with all and singular the hereditaments and appurtenances thereto belonging or *in any wise* appertaining.

Witness my hand and seal, this **26th** day of **December,** in the year of our Lord one thousand nine hundred and three.

[Seal.] **JOHN T. McDONALD.**

STATE OF COLORADO, }
County of Clear Creek, } ss.

Before me, the subscriber, a Notary Public in and for said County, personally appeared **John T. McDonald,** to me personally known to be the same person described in and who executed the within Declaration of Occupation, and acknowledged that **he** signed, sealed and published the same as **his** free and voluntary act and deed, for the uses and purposes therein set forth.

Witness my hand and notarial seal, this **twenty-sixth** day of **December,** A.D. 1903.

My commission expires December 27, 1905.

ROYAL R. GRAHAM, Notary Public.

(*Note.* — The certification before a Notary is not necessary. Another example of Mill Site Certificate will be given under Field Notes of Patent Surveying.)

The following Location Certificate, though not according to the present requirements of the General Land Office, is probably perfectly legal. To avoid trouble, however, it is best to take it up by legal subdivisions:

Placer Location Certificate

Know All Men by These Presents, that **J. M. Cross,** the undersigned citizen of the United States, resident of the County of **Clear Creek,** State of Colorado, having complied with the provisions of Chapter 6, Title XXXII, of the Revised Statutes of the United States, and with the local customs, laws and regulations, claims by right of discovery and location the **Snow Storm** Placer Claim, situate, lying

and being in **Gold Dirt** Mining District, County of **Clear Creek,** and State of Colorado, described by metes and bounds as follows, to-wit:

Beginning at Corner No. 1, thence N. 81° 42′ E. 329.85 ft. to Cor. No. 2; thence S. 35° 3′ E. 227.6 ft. to Cor. No. 3; thence S. 44° 46′ W. 213.6 ft. to Cor. No. 4; thence N. 68° 34′ W. 422.30 ft. to Cor. No. 1, the place of beginning.

From Cor. No. 1, two prominent peaks bear N. 87° 30′ W. and S. 45° W., respectively.

Containing an area of 1.808 acres, said claim was located on the **19th** day of **November,** A.D. 1902.

Date of certificate, December 1st, A.D. 1902.

J. M. CROSS.

(A Placer Location Certificate by legal subdivisions will be given under Field Notes of Patent Surveying.)

Tunnel Sites

There is considerable difference of opinion in regard to the location of tunnel sites, but the best method seems to be the surveying of the proposed line of the tunnel on the surface, and the marking of the exterior boundaries of the tunnel site. The tunnel line is easiest marked by stakes at the various points of set-up, but rather better by stakes set at regular intervals of, say, 500 feet. From the end points, stakes are set 1,500 feet on each side of the tunnel line as shown in Fig. 32. Certain ground is frequently located or staked for dumping purposes.

Location Certificate — Tunnel

To All Whom These Presents May Concern:

Know ye that I, **George E. Plant,** of **Georgetown, Colorado, on the 20th** day of **May,** 1905, located, and by these

presents do locate, for the discovery of mines and the development of lodes or veins, the **Tip Top** Tunnel and Tunnel Site, and claim the right of occupancy, possession

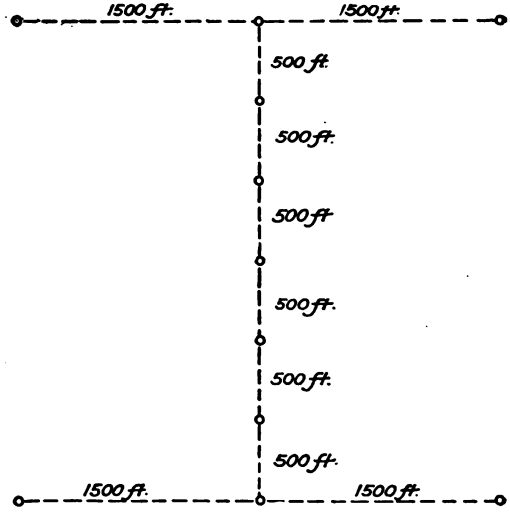


Fig. 32

and enjoyment thereof, together with the right of possession of 1,500 feet in length on all veins or lodes within 3,000 feet from the face of said tunnel, on the line thereof, not previously known to exist, discovered in said tunnel, situate in **Virginia** Mining District, **Clear Creek** County, State of Colorado.

The mouth of the tunnel (at the point where it enters cover) is located **on the North side of Cold Creek, whence Cor. No. 2, Sur. No. 16521, Colorado lode, bears S. 27° 16′ W. 351.5 ft.**

Size of tunnel, **6 feet** wide by **8 feet high in the clear.**

Course of tunnel from its mouth is **North** 3,000 feet.

A full description of the stakes set along the line of

tunnel is as follows: **Six stakes set at intervals of 500 feet for 3,000 feet from mouth.**

A full description of the stakes set at the exterior boundaries of the area claimed, 3,000 feet square, is as follows: **From the mouth of tunnel stakes set 1,500 feet west and 1,500 feet east, respectively. At 3,000 feet from mouth, stakes set 1,500 feet west and 1,500 feet east, respectively.**

I also claim for dumping purposes a tract of land described as follows: Beginning at the mouth of said tunnel, **thence E. 100 ft.; thence S. 200 ft.; thence W. 200 ft.; thence N. 200 ft.; thence E. 100 ft. to place of beginning,** together with all and singular the hereditaments and appurtenances thereunto belonging or in any wise appertaining, and all rights granted to the locator as tunnel rights under the terms of Section 2323 of the Revised Statutes of the United States.

Witness my hand and seal this **20th** day of **May,** A.D. 1905. [Seal.] GEORGE E. PLANT.

Legal Subdivisions

Locating placers by legal subdivisions of sections is closely connected with the procedure for restoring lost corners of the public survey. The subject is exhaustively handled in "Circular on Restoration of Lost or Obliterated Corners and Subdivision of Sections: General Land Office, March 14, 1901." The pamphlet may be obtained by applying to the General Land Office, Washington, D. C. Following is an account of the most important points to be kept in mind and principles to be applied. An example of the Location Certificate required will be given with the Field *Notes of a* Patent Survey.

General Rules

1st. That the boundaries of the public lands established and returned by the duly appointed government surveyors, when approved by the surveyors general and accepted by the government, are unchangeable.

2nd. That the original township, section and quarter-section corners established by the government surveyors must stand as the true corners which they were intended to represent, whether the corners be in place or not.

3rd. That quarter-quarter corners not established by the government surveyors shall be placed on the straight lines joining the section and quarter-section corners and midway between them, except on the last half mile of section lines closing on the north and west boundaries of the township, or on other lines between fractional sections.

4th. That all subdivisional lines of a section running between corners established in the original survey of a township must be straight lines running from the proper corner in one section line to its opposite corresponding corner in the opposite section line.

5th. That in a fractional section where no opposite corresponding corner has been or can be established, any required subdivision line of such section must be run from the proper original corner in the boundary line due east and west, or north and south, as the case may be, to the water course, Indian reservation or other boundary of such section, with due parallelism to section lines.

From the foregoing it will be plain that extinct corners of government surveys must be restored to their original locations whenever it is possible to do so; and hence resort should always be first had to the marks of the survey in the field. The locus of the missing corner should be first

identified on the ground by the aid of the mound, pits, line trees, bearing trees, etc., described in the field notes of the original survey.

The identification of mounds, pits, witness trees or other permanent objects noted in the field notes of survey, affords the best means of relocating the missing corner in its original position. If this cannot be done, clear and convincing testimony of citizens as to the locality it originally occupied should be taken if such can be obtained. In any event, whether the locus of the corner be fixed by the one means or the other, such locus should always be tested and confirmed by measurements to known corners. No definite rule can be laid down as to what shall be sufficient evidence in such cases, and much must be left to the skill, fidelity and good judgment of the surveyor in the performance of his work.

Subdivision of Sections

1. *Subdivision of Sections into Quarter Sections.* — Under the provisions of the Act of Congress approved February 11, 1905, the course to be pursued in the subdivision of sections into quarter sections is to run straight lines from the established quarter-section corners, United States surveys, to the opposite corresponding corners. The point of intersection of the lines thus run will be the corner common to the several quarter sections, or, in other words, the legal center of the section.

(*a*) Upon the lines closing on the north and west boundaries of a township, the quarter-section corners are established by the United States deputy surveyors at 40 chains to the north or west of the last interior section corners, *and the* excess or deficiency in the measurement is thrown

into the half mile next to the township or range line as the case may be.

(*b*) Where there are double sets of section corners on township and range lines, the quarter corners for the sections south of the township lines and east of the range lines are not established in the field by the United States deputy surveyors, but in subdividing such sections said quarter corners should be so placed as to suit the calculations of the areas of the quarter sections adjoining the township boundaries, as expressed upon the official plat, adopting proportionate measurements where the new measurements of the north and west boundaries of the section differ from the original measurements.

2. *Subdivision of Fractional Sections.* — Where opposite corresponding corners have not been or cannot be fixed, the subdivision lines should be ascertained by running from the established corners due north, south, east or west lines, as the case may be, to the water course, Indian boundary line or other boundary of such fractional section.

(*a*) The law presumes the section lines surveyed and marked in the field by the United States deputy surveyors to be due north and south or east and west lines, but in actual experience this is not always the case. Hence, in order to carry out the spirit of the law, it will be necessary in running the subdivisional lines through fractional sections to adopt mean courses where the section lines are not due lines, or to run the division line parallel to the east, south, west or north boundary of the section, as conditions may require, where there is no opposite section line.

3. *Subdivision of Quarter Sections into Quarter-Quarters.* — Preliminary to the subdivision of quarter sections, the quarter-quarter corners will be established at points mid-

way between the section and quarter-section corners, and between quarter corners and the center of the section, except on the last half mile of the lines closing on the north or west boundaries of a township, where they should be placed at 20 chains, proportionate measurement, to the north or west of the quarter-section corner.

(*a*) The quarter-quarter section corners having been established as directed above, the subdivision lines of the quarter section will be run straight between opposite corresponding quarter-quarter section corners on the quarter-section boundaries. The intersection of the lines thus run will determine the place for the corner common to the four quarter-quarter sections.

4. *Subdivision of Fractional Quarter Sections.* — The subdivision lines of fractional quarter sections will be run from properly established quarter-quarter section corners (paragraph 3) due north, south, east or west, to the lake, water course or reservation which renders such tracts fractional, or parallel to the east, south, west or north boundary of the quarter section, as conditions may require. (See paragraph 2–*a*.)

5. *Proportionate Measurement.* — By "proportionate measurement," as used in this circular, is meant a measurement having the same ratio to that recorded in the original field notes as the length of chain used in the new measurement has to the length of chain used in the original survey, assuming that the original and new measurements have been correctly made.

For example: The length of the line from the quarter-section corner on the west side of Sec. 2, T. 24 N., R. 14 E., Wisconsin, to the north line of the township, by the United States deputy surveyor's chain, was reported as 45.40 chains, and by the county surveyor's measure is reported

as 42.90 chains; then the distance which the quarter-quarter section corner should be located north of the quarter-section corner would be determined as follows:

As 45.40 chains, the government measure of the whole distance, is to 42.90 chains, the county surveyor's measure of the same distance, so is 20.00 chains, original measurement, to 18.90 chains by the county surveyor's measure, showing that by proportionate measurement, in this case, the quarter-quarter section corner should be set at 18.90 chains north of the quarter-section corner, instead of 20.00 chains north of such corner, as represented on the official plat. In this manner the discrepancies between original and new measurements are equitably distributed.

The foregoing will be clear from an inspection of Fig. 33. We will assume that the corners actually existing on the

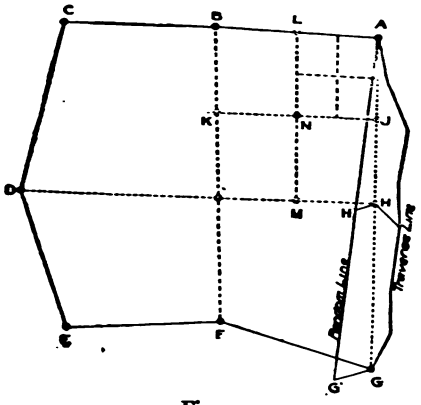


Fig. 33

ground are represented by the points *A B C D E F G*, while corner *H* is missing. This corner is reëstablished by placing it on a straight line halfway between *A* and *G*. When the character of the country permits, this had best be done by running a random line (straight trial line),

as nearly direct from A to G as possible. This line will probably fall somewhat to the east or west of G. Set at F. From G the course and distance are measured to G. At a point halfway between A and G on the line AG run a line parallel to GG and half the length of GG to H. This H is on line AG equidistant from A and G.

In rough country it will often be easier or even necessary to run a traverse from A to G, figure the missing course, and thus find the course and distance directly from A to G. Half of this distance is the distance from G to H. This may either be run directly on the ground from G or A, or, better still, the position for H may be found by figuring the course and distance from the nearest station used on the traverse from A to G, for which all the latitudes and departures have been previously figured in order to determine AG.

In a similar way the line between H and D is run, and its interior corner I is established at the point of its intersection with the line BF. Midway between B and I, K is established, and J between A and H. Halfway between A and B establish L and similarly M between H and I. This same principle will determine the reëstablishment of lost corners, or the subdivision of the whole section.

Should the section be on the western tier of the township, it must be remembered that the eastern portions of the sections are subdivided as nearly as possible according to the dimensions of a perfect section, and all the error thrown into the western portion.

Tracing Extensions of Veins on the Surface

On the borderland between surface and underground surveying, one of the operations that a western surveyor is *frequently* called upon to perform is tracing the extension

of a known vein or finding from underground workings the probable outcrop of a vein. This may be done with various solars with great ease, as afterwards described, but with an ordinary transit it requires considerable calculation.

Let Fig. 34 in plan, vertical and longitudinal section, represent the simplest possible case, a vein striking due north and running up a regularly sloping hillside. The problem is to find the direction of the apex and the point on the surface approximately 600 feet away where the vein outcrops. From the tunnel the strike of the vein is found to be north, or assumed to be so for simplicity, and the dip is found to be 55° 30′. Measuring 600 feet up the hill, north, the same direction as the tunnel is assumed, the angle of elevation is found to be 30° 33′, which gives us a perpendicular height of 304.9. From this, with the angle of dip 55° 30′, we find we have to measure 209.5 feet at right angles to the strike to reach the apex. Should only the course of the apex be desired, we have only

$$\frac{516.7}{209.5} = \text{cot course}$$

$$\log 516.7 = 2.713238$$
$$\log 209.5 = 2.321184$$
$$0.392054 = \log \cot 22° 4'$$
or N. 22° 4′ W.

It will usually happen, however, that A is not on a level with B, and therefore some correction must be added to or subtracted from 209.5 feet, as the point A is above or below B, as shown in Fig. 34*d*. This correction, of course, varies as the height varies above or below B, and is figured from this height with an angle of 55° 30′, as the 209.5 feet was figured from 304.5 feet in Fig. 34*c*.

This work may be greatly simplified by the use of spherical trigonometry. In a spherical right triangle (Fig. 35) take A as the *dip of the* vein, b as the angle between

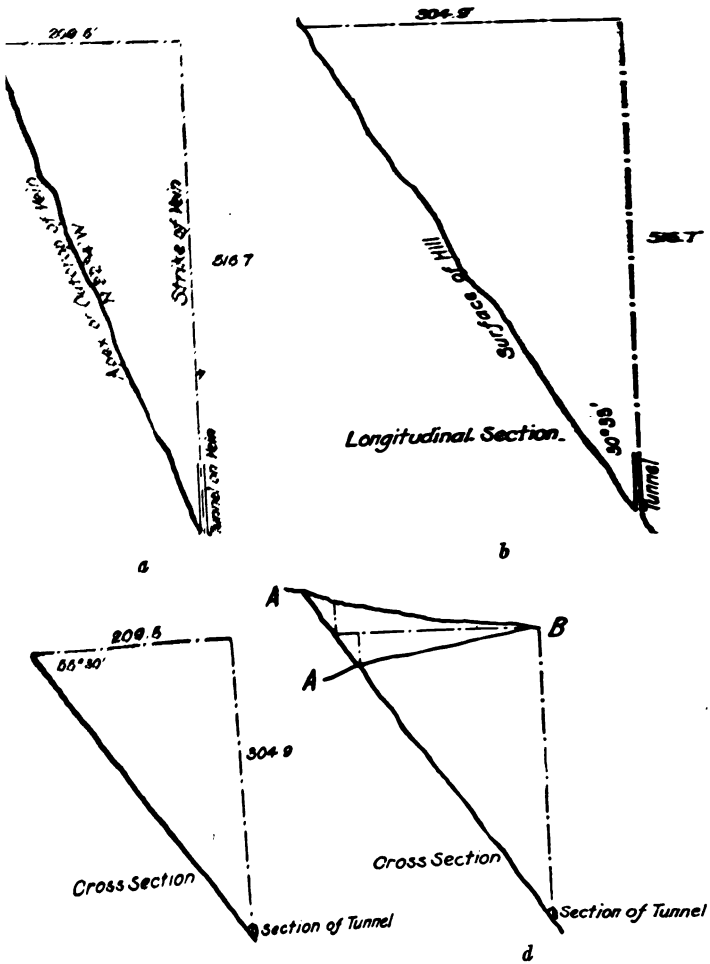


Fig. 34

direction of outcrop and strike of vein and a dip of line of outcrop or slope of hill on line of outcrop. Then

$$\sin b = \tan a \cot A;$$

at is, sine of angle between direction of outcrop and

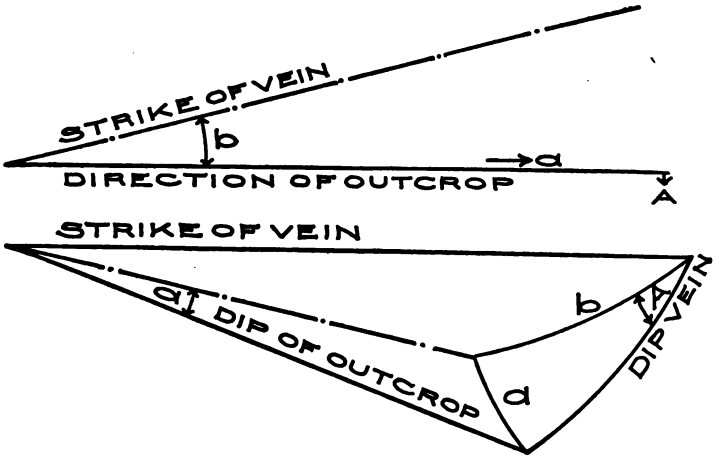


Fig. 35

strike of vein is equal to tangent dip of line of outcrop by cotangent dip of vein.

The following table gives the values of sin *b* for various dips of vein and outcrop.

Dip vein.	Dip outcrop.							
	5°	10°	15°	20°	25°	30°	35°	40°
20°	13° 54′	28° 59′	47° 24′	90° 0′				
25	10 49	22 13	35 4	51 18	90° 0′			
30	8 43	17 47	27 39	39 5	53 52	90° 0′		
35	7 11	14 36	22 30	31 19	41 45	55 33	90° 0′	
40	5 59	12 8	18 38	25 43	33 45	43 29	56 34	90° 0′
45	5 1	10 9	15 32	21 22	27 48	35 16	44 27	57 3
50	4 12	8 31	13 0	17 47	23 2	28 59	35 59	44 45
55°	3° 31′	7° 5′	10° 49′	14° 46′	19° 3′	23° 51′	29° 22′	35° 59′
60	2 54	5 50	8 54	12 8	15 37	19 28	23 51	28 59
65	2 20	4 43	7 10	9 46	12 34	15 37	19 3	23 2
70	1 49	3 41	5 36	7 37	9 46	12 07	14 46	17 47
75	1 21	2 42	4 7	5 36	7 10	8 54	10 49	12 59
80	0 53	1 47	2 42	3 41	4 42	5 50	7 5	8 31
85	0 26	0 53	1 21	1 50	2 20	2 54	3 31	4 12

Vein Tracing with the Solar Attachment

If the Shattuck Solar Attachment is used this becomes a very simple operation and is performed as follows:

The dip and strike of the vein are first determined by any convenient means. The transit is then set over an outcrop of the vein and the solar attached with the mirror set to deflect the line of collimation through an angle of 90°.

The telescope is pointed in a direction perpendicular to the plane of the vein, by deflecting an angle of 90° from the strike of the vein, and setting off on the vertical limb an angle of 90° from the dip of the vein.

The solar revolved on its axis will then cut a plane of the vein. The line where this plane cuts the surface of the ground is the line of the apex of the vein, which may be traced by simply sighting through the solar. Its position may be marked with equal facility where it crosses gulches or hillsides.

In case there are two openings at different elevations on the apex of a slanting vein, the strike of the vein may be determined in a similar manner.

Place the transit, with solar attached, over one of the croppings; depress the telescope to an angle of 90° plus the dip of the vein, and direct the telescope toward the footwall of the vein. Sight through the transit and solar at the other outcrop. The vernier reading will then be 90° from the strike of the vein.

The same results may be obtained in a similar way by the use of a solar provided with a telescope, as, for example, the Berger or Saegmuller Solars. For vein tracing the auxiliary telescope of the solar is set exactly parallel to the main telescope of the transit in the same vertical plane. The auxiliary telescope is then pointed in the direction of

the dip, as, for example, down a shaft, and at right angles to the strike of the vein. If the auxiliary telescope is now revolved on the adaptor or whatever device is employed, on a plane parallel to the plane of the vein, it will always point to some spot on the outcrop, provided, of course, the dip and strike are regular. In this way the outcrop may be staked by sighting directly through the telescope, a process somewhat simpler and clearer than the reflections of the Shattuck Solar.

The top telescope alone of a mining transit may be used, provided it will turn on the point of attachment as in the Scott model. This may be turned, after it is tightly set, by loosening the capstan screw.

CHAPTER V

PATENT SURVEYS

Surveying for Patent

We now come to that portion of western mineral surveying where the assistance of a mineral surveyor is required, namely, surveying for patent. As a rule, before beginning patent proceedings, the correctness of the location surveys is carefully verified, or the surveys are corrected and modified as required. In the case of groups it is especially necessary that the exact status of things be known before an order for survey is requested from the surveyor general. This done, the claimant or his attorney deposits the fees for the surveyor general's office at the nearest United States depository, with the name of the claimant and the name of the claim to which the fees are to apply.

Then, using the proper blanks which are supplied by the surveyor general, the claimant applies to the surveyor general to issue an order for survey. This form is given later under Specimen Field Notes. With this application are forwarded certified copies of the location certificates.

At the present writing, the mineral surveyor is strictly forbidden to either send the money to the United States depository, or make out the application to the surveyor general for survey, and is strictly forbidden to act as attorney in any way for the claimant. He may not even make an estimate to the claimant of the probable cost of *complete* patent. This also applies to his chainman.

The certified copies of location certificates are carefully examined in the surveyor general's office, and if any mistakes are found, are returned for correction. Here it may be observed that the commonest mistakes found in these certificates are in angular claims which fail to close. If the certificates are satisfactory they are copied in the surveyor general's office and the copies, with the order of survey, are sent to the United States mineral surveyor designated in the application.

This order is also given later under Specimen Field Notes.

The mineral surveyor then surveys the claim exactly as described for a location survey, except that the work is done much more carefully and with greater safeguards. In place of the stakes used in the location survey, stones, rocks in place, substantial posts, or even trees, are used for corners. If the ground is such that it is impossible to set a corner, or if it is seen that a corner cannot possibly be permanent if set, a witness corner is placed on one of the lines of the survey, but not off these lines, except when absolutely necessary. Cor. No. 1 is placed on the end of the claim nearest the section corner or monument of the

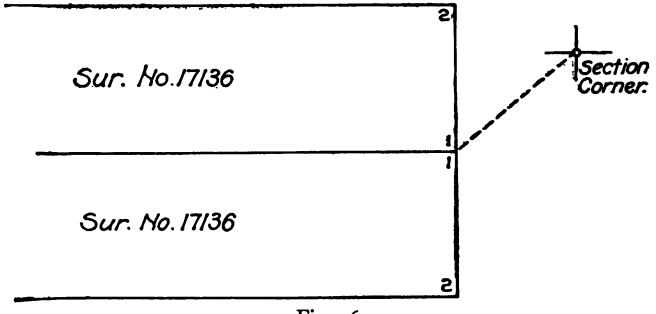


Fig. 36

public survey. Where there is a group of claims with common corners, as shown in Fig. 36, it is customary to

have Cor. No. 1 common to two claims and thus save considerable field work and calculation. Up to the present time this has been permitted by the General Land Office.

In case the surveyor has not carefully verified his location certificates in advance, he may find that the conditions on the ground do not fit the descriptions in the certificates. Usually a slight divergence of a few minutes or a few feet is permitted by the surveyor general. In case the divergence is material, it is necessary to amend the locations, and the claimant must apply for a new order for survey. This new order costs $5 and results in the issuance of a new number and the cancellation of the old number. Therefore it is stated again that too much care cannot be taken to verify the descriptions in the location certificates before an order is requested.

Wherever possible, bearings are taken from the corners set to blazed trees, rocks in place, boulders, and, lastly, to mountain peaks, or permanent objects. The blazed trees and stakes are marked with a timber scribe, and the rocks and stone corners are chiseled.

The tie to a section corner may often be made directly from some convenient point during the process of the survey and the missing course figured from Cor. No. 1, as given above under Location Surveys. As a rule, more or less of a traverse must be made to the section corner and afterwards the direct course from Cor. No. 1 is figured. When the surveyor has a claim that he has previously surveyed for patent in the vicinity, which is tied to a section corner, he may run to this claim and figure his section tie through it. Should he tie through any other claim not his own survey, the work must be thoroughly checked. This practically means that he can use another's survey only as a help to find the section corner. At present, the

surveyor is required to report all these ties as run directly on the ground, from Cor. No. 1 of the claim to the section corner or locating monument. Ties made to a United States locating monument are in every way the same as ties made to section corners.

A general description of the corner or monument tied to must be given in the notes, examples of which will be given later on.

In many districts, such as the Clear Creek and Gilpin districts, the work of connecting the corners of the public survey is greatly facilitated by a number of triangulation systems in which each station of the system is tied to some corner of the public survey. In some cases these triangulation systems are official, and figure on the maps in the surveyor general's office, but in most cases they are simply private aids. With these systems the mineral surveyor has simply to tie to some triangulation station, and at his office has the bearing and distance from this station (with its latitude and departure) all figured out to the section corner. He has only to add this latitude and departure to this traverse to the triangulation station in order to figure his section tie. The triangulation systems are also useful for deflecting lines.

Thus, one may set up on a triangulation station, sight to some other triangulation station, the course of which is known, and thence run to the claim to be surveyed, carrying the course with him. In this way the figuring of a direct observation is avoided. (Plate I.)

Ties to other claims are made from the most convenient points on the survey, but, as a rule, they are much shorter than the section tie. At the present time, these also are reported as run direct upon the ground. In order th the exact position of each conflicting claim may be know

ties must be made to every corner terminating a line in conflict with the claim being surveyed. In case some of the required corners on a conflicting claim are missing, the lines are treated in a manner to be described later on. In case no corners at all are to be found, and no bearing trees, bearing rocks, etc., it is necessary to tie to the discovery shaft of the conflicting claim. If the discovery shaft cannot be identified, the claim must be treated descriptively; this case will be taken up under examples of figuring. As with the corner of a public survey, the corners of all claims tied to must be described in a general way as stone, post, etc., and the markings noted.

All workings and improvements, such as shafts, tunnels, adits, buildings, etc., are tied in from convenient points on the survey, and the courses and dimensions taken. They are eventually figured to some corner of the claim.

Roads, gulches, creeks, hill crests, county lines, etc., are picked up in the course of the survey and enough of them run out so that they can be indicated on the map and the general direction and intersection with the boundaries of the claim known.

Up to this time the survey has been treated as though one location at a time were being surveyed, or, in the case of many locations, as if each one were being surveyed as a unit. In the case of groups of claims, the surveying may often be greatly simplified by a little forethought. This is evident in the case of those locations which lie side by side, when one surveyed center line may serve for the whole group, the end lines being run from its two ends.

In the case of a whole group where the claims are irregularly arranged, it is well to make a closed traverse including all the discovery shafts, before an application for an *order of survey* is made. This traverse is then platted

and the claims arranged in the manner best suited to cover the veins and ground desired. The surveyor then figures out the fewest lines that can possibly be run which will take in all the corners and improvements. In this way the running of the center line of each claim is avoided. If the original traverse stakes have remained in place, it is often possible to put in many of the corners from them without further surveying. This applies only in the preliminary work, as in the final survey the Land Office requires that all boundary lines shall be run out. The surveyor must also make sure that he really has a group before the claimant applies for an order for survey; that is, he must be sure that the claims actually conflict continuously or are contiguous, having boundary lines, and not merely certain corners, in common.

After the survey is completed it is carefully platted, usually on a scale of 200 feet to the inch. The use of drawing paper on which a protractor is engraved greatly facilitates the platting. The lines are carried from the protractor by a parallel rule. The plat made, the figuring of intersections and areas is begun.

Angles from Courses

Before taking up patent figuring it will be well to show how the angles of the various triangles are found.

To determine the value of the various angles of triangles, the directions of whose sides are designated by courses, is somewhat confusing to the beginner, especially if he is not thoroughly familiar with field methods. Fig. 37, *A*, *B*, *C* and *D*, shows the four possible cases, the angles in question being the interior angles between solid lines. *A* shows the simplest possible case. Each course being S. W., we simply subtract 20° from 60° and get the angle 40°. In

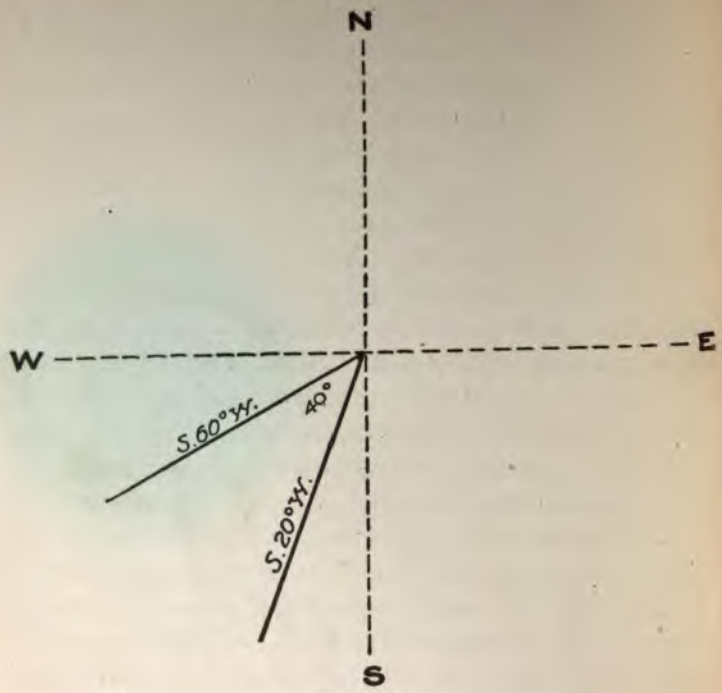


Fig. 37 *A*

B we have a case, on each side of the north and south line, and the amounts of the two courses have simply to be added to obtain the required angle. Thus $70° + 34° = 104°$. In *C* the amounts of the two courses are added and the sum subtracted from 180°. Thus, $40° + 55° = 95°$, $180° - 95° = 85°$, or $90° - 40° = 50°$, and $90° - 55° = 35°$, $35° + 50° = 85°$, the angle required. For *D* the included angle may be obtained in three different ways. The difference in course may be obtained and then subtracted from 180°, as $60° - 20° = 40°$, $180° - 40° = 140°$, or $180° - 60° = 120° + 20° = 140°$, or $90° - 60° = 30° + 90° + 20° =$

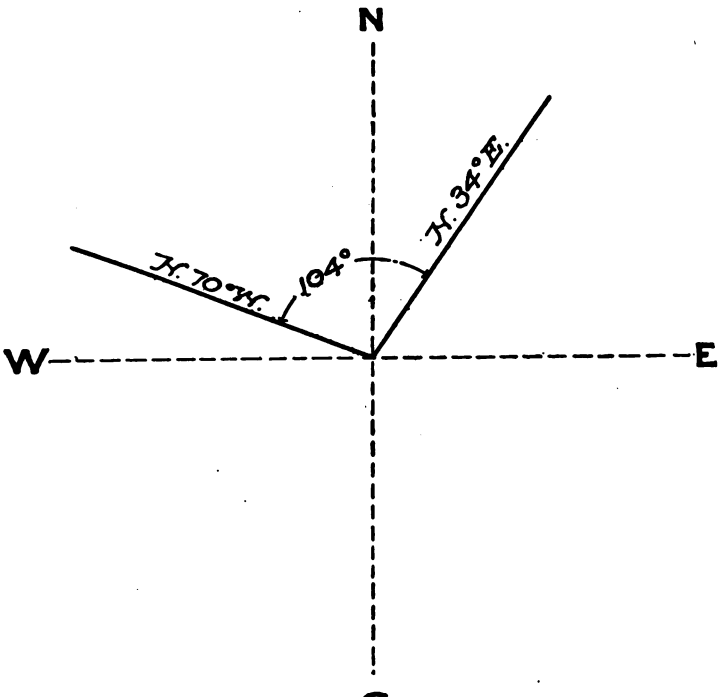


Fig. 37 *B*

140°, the angle required. The reverse of these methods may of course be used in deriving courses from angles.

Patent Figuring of Survey No. 17846

Taking Sur. No. 17846 in Plate II as the claim to be patented, the section tie from Cor. No. 1 of the claim is figured by means of the missing course of the traverse actually measured from the end center. Thus, beginning at Cor. No. 1, thence to No. 1, thence to No. 2, thence to No. 3, or the section corner, thence by missing course to Cor. *No. 1.*

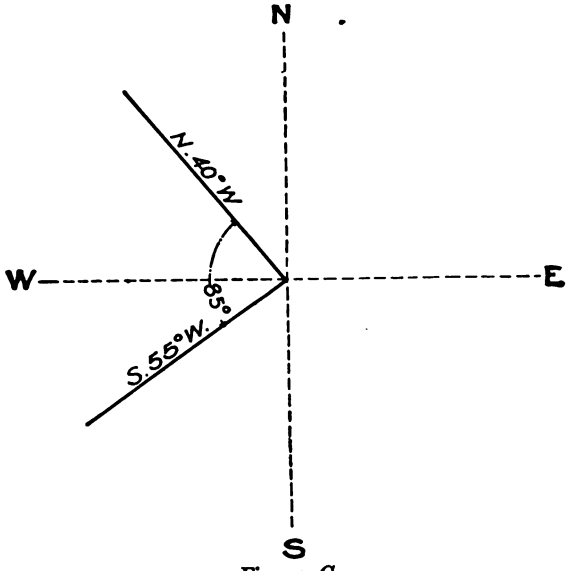


Fig. 37 *C*

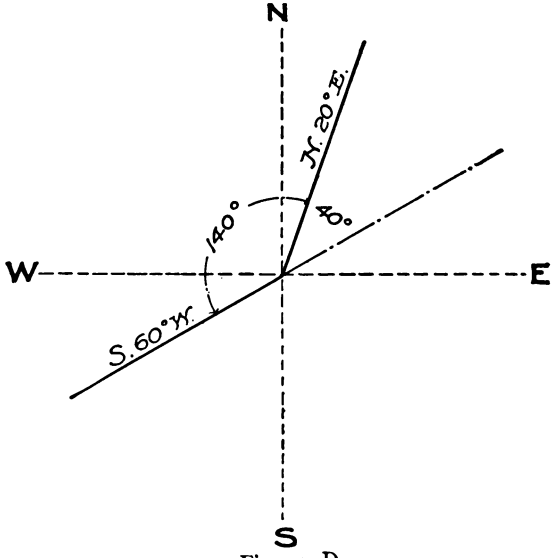


Fig. 37 D

PAGE FROM NOTE BOOK, SUR. NO. 17846

At station.	B. S. station	Vert angle.	Slope dist.	Hor. dist.	True course.	To station.	Remarks.
1	0	0°		335.6	N. 75° E.	4	1 = on end line.
4	1	10	294.6	290.1	N. 75 E.	7	
7	4	11 15′	424.5	416.3	N. 75 E.	8	
8	7	6 30	461.0	458.0	N. 75 E.	9	On end line.
				1500.0			
1	0	12	405.2	396.2	N. 81 W.	2	For sec. tie.
2	1	9	333.7	329.5	N. 50 W.	3	= sec. cor. 6 × 9 × 16 ins. above ground, 1111 So.
1	0	0	110.0		N. 75 E.		Dis. 4 × 6, 65 deep. Timbered 30 feet.
4	1	10	482.1	474.8	N. 14 46′ E.	5	
5	4	5	218.8	217.9	N. 29 39 W.		1 — 16591 stone
5	4	5	232.5	231.5	N. 54 3 E.		2 — 16591 stone.
4	1	0		703.3	S. 4 2 W.	6	
6	4	4	240.6	240.0	S. 58 19 W.		4 — 16591 stone.
6	4	4	201.7	201.2	S. 26 53 E.		3 — 16591 stone.
4	1	3	87.5	87.4	S. 50 16 E.		1 — 17541 stone.
7	4	0	56.6	56.6	N. 89 22 E.		2 — 17541 stone. (No cors. at S. end.)
8	7	0	62.3	62.3	N. 40 32 W.		2 — 12716 stone.
2. 12716				300.0	N. 39 W.		1 — 12716 stone.
8	7	8	151.0	149.5	S. 45 10 E.		4 — 17650 stone.

No cors. or disc found on 1462.

(Note Cors. 3 and 4 — 12716; Cors. 1, 2, 3, 5, 6 — 17560; known by previous official work.)

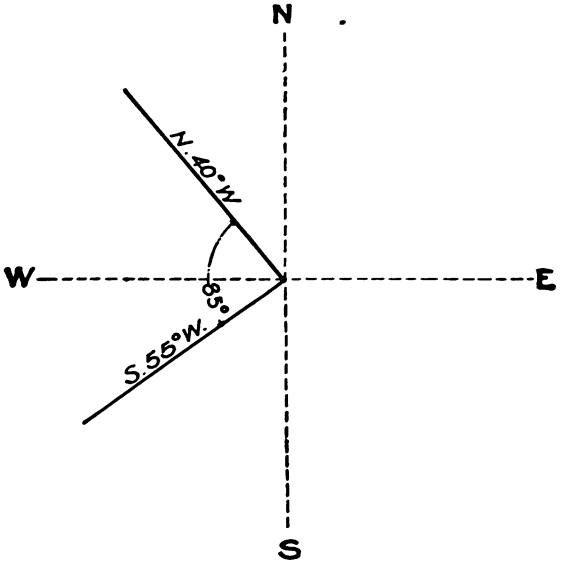


Fig. 37 C

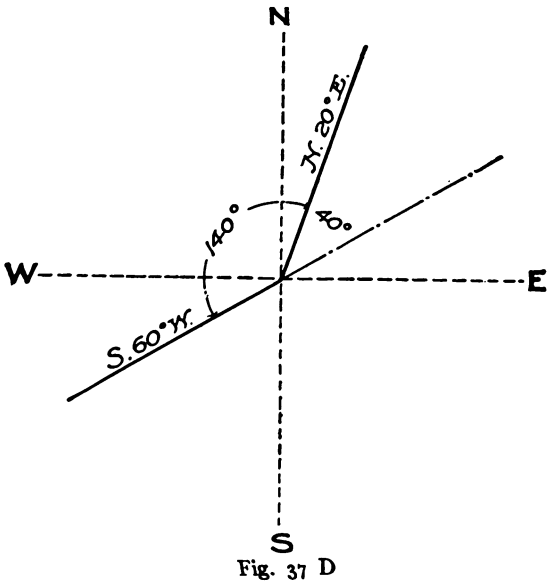


Fig. 37 D

PAGE FROM NOTE BOOK, SUR. NO. 17846

At station.	B. S. station	Vert angle.	Slope dist.	Hor. dist.	True course.	To station.	Remarks.
1	0	0°		335.6	N. 75° E.	4	1 = on end line.
4	1	10	294.6	290.1	N. 75 E.	7	
7	4	11 15′	424.5	416.3	N. 75 E.	8	
8	7	6 30	461.0	458.0	N. 75 E.	9	On end line.
				1500.0			
1	0	12	405.2	396.2	N. 81 W.	2	For sec. tie.
2	1	9	333.7	329.5	N. 50 W.	3	= sec. cor. 6 × 9 × 16 ins. above ground, 1111 So.
1	0	0	110.0		N. 75 E.		Dis. 4 × 6, 65 deep. Timbered 30 feet.
4	1	10	482.1	474.8	N. 14 46′ E.	5	
5	4	5	218.8	217.9	N. 29 39 W.		1 — 16591 stone
5	4	5	232.5	231.5	N. 54 3 E.		2 — 16591 stone.
4	1	0		703.3	S. 4 2 W.	6	
6	4	4	240.6	240.0	S. 58 19 W.		4 — 16591 stone.
6	4	4	201.7	201.2	S. 26 53 E.		3 — 16591 stone.
4	1	3	87.5	87.4	S. 50 16 E.		1 — 17541 stone.
7	4	0	56.6	56.6	N. 89 22 E.		2 — 17541 stone. (No cors. at S. end.)
8	7	0	62.3	62.3	N. 40 32 W.		2 — 12716 stone.
2.12716				300.0	N. 39 W.		1 — 12716 stone.
8	7	8	151.0	149.5	S. 45 10 E.		4 — 17650 stone.

No cors. or disc found on 1462.
(Note Cors. 3 and 4 — 12716; Cors. 1, 2, 3, 5, 6 — 17560; known by previous official work.)

			N. lat.	S. lat.	E. d'p.	W. d'p.
			.....	144.88	38.82	.....
			88.08	.....	.....	391.31
			211.79	.....	.....	252.41
			273.71	144.88	38.82	643.72
			144.88			38.82
			128.83			604.90

For the remaining area, Survey No. 10501, the missing [illegible] lines of the line actually traversed. Below is the area is surveyed and described [illegible] with all error [illegible] more than 1 foot in 2,000.

Station.	Course.	Dist.	N. lat.	S. lat.	E. d'p.	W. d'p.
1–16591 — No. 5	S. 29° 39′ E.	217.9	.....	189.35	107.78	.....
No. 5 — No. 4.....	S. 14 46 W.	474.8	.....	459.11	.....	121.01
No. 4 — No. 6.....	S. 4 2 W.	703.3	.....	701.55	.....	49.46
No. 6 — 4–16591	S. 58 19 W.	240.0	.....	126.05	.....	204.23
4–16591 — 1–16591	N. 10 15 E.	1500.0	1476.06	.....	266.92	.....
			1476.06	1476.06	374.70	374.70

Station.	Course.	Dist.	N. lat.	S. lat.	E. d'p.	W. d'p.
2–16591 — No. 5.....	S. 54° 3′ W.	231.5	.....	135.91	.....	187.40
No. 5 — No. 4.....	S. 14 46 W.	474.8	.....	459.11	.....	121.01
No. 4 — No. 6.....	S. 4 2 W.	703.3	.....	701.55	.....	49.46
No. 6 — 3–16591.....	S. 26 53 E.	201.17	.....	179.42	90.95	.....
3–16591 — 2–16591 ...	N. 10 15 E.	1500.0	1476.06	.....	266.92	.....
			1476.06	1475.99	357.87	357.87

Station.	Course.	Dist.	N. lat.	S. lat.	E. d'p.	W. d'p.
1–16591 — No. 5.....	S. 29° 39′ E.	217.9	.....	189.35	107.78	.....
No. 5 — 2–16591.....	N. 54 3 E.	231.54	135.91	.....	187.42	.....
2–16591 — 1–16591.....	N. 79 45 W.	300.00	53.38	.....	.....	295.21
			189.29	189.35	295.20	295.21

Station.	Course.	Dist.	N. lat.	S. lat.	E. d'p.	W. d'p.
3–16591 — No. 6.....	N. 26° 53′ W.	201.2	179.45	.....	.....	90.97
No. 6 — 4–16591.....	S. 58 19 W.	240.00	.....	126.05	.....	204.23
4–16591 — 3–16591.....	S. 79 45 E.	300.00	.....	53.38	295.21	.....
			179.45	179.43	295.21	295.20

Conflict with Sur. No. 16591

We are now in a position to figure the tie from Cor. No. 1, Sur. No. 17846, to Cor. No. 1, Sur. No. 16591, by missing course as follows:

Station.	Course.	Dist.	N. lat.	S. lat.	E. d'p.	W. d'p.
1–17846 — No. 1.....	S. 15° E.	150.00	.....	144.88	38.82	.....
No. 1 — No. 4.....	N. 75 E.	335.6	86.86	.....	324.15	.....
No. 4 — No. 5.....	N. 14 46′ E.	474.8	459.11	.....	121.01	.....
No. 5 — 1–16591.....	N. 29 39 W.	217.9	189.35	.....	.....	107.78
			735.32	144.88	483.98	107.78
			144.88		107.78	
			590.44		376.20	

$\log 590.44 = 2.771176$ $\quad$ $\log 590.44 = 2.771176$
$\log 376.20 = 2.575419$ $\quad$ $\log \cos 32° 31′ = 9.926029$

$\cot 32° 30′ = 0.195757$ $\quad$ $\log 700.08 = 2.845147$

Tie N. 32° 30′ E. 700.08 feet.

32° 30′	700.0	590.37	376.11
	0.08	0.06	0.04
To check		590.43	376.15

We now figure the triangle *abc*, in which we have the course and length of *ab* given, namely, N. 32° 30′ E. 700.08 feet. Subtracting courses to find angles, we get:

$a = 32° 30′$	$b = 75° 00′$	$c = 10° 15′$	$a = 22° 15′$
$10° 15′$	$32° 30′$	$90° 00′$	$b = 42° 30′$
$22° 15′$	$42° 30′$	$15° 00′ = (90° - 75°)$	$c = 115° 15′$
		$115° 15′$	$180° 00′$

$\sin 115° 15′ : 700.08 = \sin 22° 15′ : ?$
$\sin 115° 15′ : 700.08 = \sin 42° 30′ : ?$

$\log 700.08 = 2.845147$ $\quad$ $\log 700.08 = 2.845147$
$\log \sin 22° 15′ = 9.578236$ $\quad$ $\log \sin 42° 30′ = 9.829683$
$\operatorname{colog} \sin 115° 15′ = 0.043613$ $\quad$ $\operatorname{colog} \sin 15° 15′ = 0.043613$

log 293.08 $= 2.466996$ $\quad$ $\log 522.90 = 2.718443$

By dividing the above triangle into two right triangles, using as the hypothenuse in each case the distance just found, the triangle may be rapidly checked with a traverse table. (See Fig. 38.)

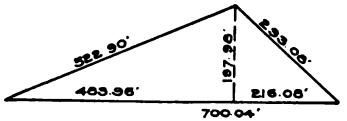


Fig. 38

Angle.	Hypothenuse.	Base.	Perpendicular.
22° 15′	522.90		
	520.00	481.28	196.89
	2.90	2.68	1.09
		483.96	197.98
42° 30′	293.08		
	290.00	213.81	195.92
	3.00	2.21	2.02
	0.08	0.06	0.05
		216.08	197.99
483.96			
216.08			
700.04			

The sum of the two bases of the right triangles equals the length of the original side. The perpendiculars are identical.

The angle *e* of the right triangle *dec* is known (79° 45′ + 75° = 154° 45′; 180° − 154° 45′ = 25° 15′) to be 25° 15′. We know *de* is 300 feet, the width of the claim, therefore, 300 is multiplied by the tan *e* to get *cd*. The length of the line *ce* may be found by multiplying 300 by the nat secant of *e*, or 300 may be divided by the cos of 25° 15′.

nat tan 25° 15′	= 0.47163	nat secant 25° 15′	= 1.105638
	300		300
	141.489		331.6914

log 300 = 2.477121
log cos 25° 15′ = 9.956387
log 331.69 = 2.520734

Here natural functions may be used with great advantage, as *de* is, with rare exceptions, 150, 300 or 600 feet, the width of the claim. The natural tangent of *e* may then be rapidly multiplied by 300 or 600, and in case of 150, quickly halved, and the half added to the tangent and multiplied by 100. The secant is treated in the same way.

The triangle *lnc* is, of course, equal to the triangle *dec*.

By subtracting 141.49 from 522.90 we get 381.41, the length of the line from Cor. No. 2, Sur. No. 16591, to the intersection of line 1–4, Sur. No. 17846. All the sides of the parallelogram *cehn* are, of course, of equal length and 331.69 feet. We therefore have *n* and *h* 854.59 and 713.10 feet, respectively, distant from Cors. Nos. 1 and 2, Sur. No. 16591. By subtracting these distances from 1,500 we get the respective distances from Cors. Nos. 4 and 3.

The distances of *e* and *h* from Cors. Nos. 1 and 2 of Sur. No. 17846 are found in the same way.

293.08	293.08
141.49	331.69
151.59	624.77 = distance to *e*
331.69	
483.28 = distance to *h*	

The area of the parallelogram *cehn* is found by multiplying 331.69 by 300, the width of the claim, and dividing by *43,560, the* number of square feet in an acre.

log 331.69	= 2.520734	log 331.69	= 2.520734
log 300	= 2.477121	log 300	= 2.477121
colog 43560	= −5.360912		4.997855
log 2.284 acres =	0.358767	log 43560	= 4.639088
		log 2.284 acres =	0.358767

The process is somewhat simplified by adding the colog as given above.

Conflict With Sur. No. 17541

In the case of Sur. 17541 we find Cors. Nos. 1 and 2, but not Cors. Nos. 3 and 4. The line 1–2 is found by our survey to be correct and Cors. Nos. 3 and 4 are then placed S. 26° E. 1,500 feet away as given in the notes of the survey for patent of Sur. No. 17541. We then figure the tie from Cor. No. 2, Sur. No. 17846, to Cor. No. 1, Sur. No. 17541.

Station.	Course.	Dist.	N. lat.	S. lat.	E. d'p.	W. d'p.
2–17846 — No. 1.....	N. 15° W.	150.00	144.88	.....	.....	38.82
No. 1 — No. 4.....	N. 75 E.	335.6	86.86	.....	324.15	.....
No. 4 — 1–17541.....	S. 50 16′ E.	87.4	.....	55.86	67.21	.....
			231.74	55.86	391.36	38.82
			55.86		38.82	
			175.88		352.54	

log 175.88	= 2.245242	log 352.54	= 2.547208
log 352.54	= 2.547208	log sin 63° 29′	= 9.951728
log cot 63° 29′	= 9.698034	log 393.98	= 2.595480

Tie N. 63° 29′ E. 393.98 feet.

63° 29′

300.0	= 133.94	268.44
93.0	= 41.52	83.22
0.98	= 0.44	0.88
To check	175.90	352.54

We now find the triangle *jik*:

$j = 63° 29'$	$i = 75°$	$k = 26°$ 180°	$j = 89° 29'$
$26°$	$63° 29'$	$75°$ 101°	$i = 11° 31'$
$89° 29'$	$11° 31'$	101° 79°	$k = 79°$
			$180° 00'$

sin 79° 00′ : 393.98 = sin 11° 31′ : ?
sin 79° 00′ : 393.98 = sin 89° 29′ : ?

log 393.98	= 2.595480	log 393.98	= 2.595480
log sin 11° 31′	= 9.300276	log sin 89° 29′	= 9.999982
colog sin 79° 00′	= 0.008053	colog sin 79° 00′	= 0.008053
log 80.13	= 1.903809	log 401 34	= 2.603515

Then for the triangle *pko′* we have the angle $k = 11°$ ($75° - 64° = 11°$) and as it is a right triangle, we work it as in the case of the triangle *dec* given above.

nat tan 11° = 0.19438	nat sec 11° = 1.0187
300	300
58.314	305.6100

log 300 = 2.477121
log cos 11° = 9.991947
log 305.61 = 2.485174

With 80.13 from above and 138.44 · (58.31 + 80.13) we have the two parallel sides of the trapezoid *jkpo*, and the area is found as follows:

138.44	log 109.28 = 2.038541
80.13	log 300 = 2.477121
2)218.57	colog 43,560 = −5.360912
109.28	log 0.7526 = −1.876574

log 109.28 = 2.038541
log 300 = 2.477121
4.515662
log 43560 = 4.639088
log 0.7526 = 1.876574

To get the net area of the conflict between Sur. No. 17846 and Sur. No. 17541, that is, exclusive of the conflict between Sur. No. 17846 and Sur. No. 16591, we must figure the quadrilateral *jkhr*. From previous figuring we have the distance from Cor. No. 2, Sur. No. 17846, to *k* and *h*, respectively, and by subtracting, we thus get *kh* to be 81.94 feet (483.28 − 401.34). From this we may figure the quadrilateral in two ways: either as two triangles, or by prolonging it to *k'*, and figuring the triangle *jk'r*.

The easiest way to figure *jh* is by missing course as follows:

Station.	Course.	Dist.	N. lat.	S. lat.	E. d'p.	W. d'p.
j — *k*.....	S. 26° E.	80.13	.....	72.02	35.13	.....
k — *h*.....	N. 75 E.	81.94	21.21	.....	79.16	.....
			21.21	72.02	114.29	
				21.21		
				50.81		

log 50.81 = 1.705949
log 114.29 = 2.058007
log cot 66° 2′ = 9.647942

log 114.29 = 2.058007
log sin 66° 2′ = 9.960843
log 125.07 = 2.097164

Course N. 66° 2′ W. 125.07 feet.

66° 2′	100.0 = 40.62	91.38
	25.0 = 10.15	22.84
	0.07 = 0.03	0.06
To check	50.80	114.28

We find the area of *jkh* as follows:

j = 66° 2′	*k* = 26°	*h* = 66° 2′	180°	*j* = 40° 2′
26°	75°	75°	141° 2′	*h* = 38° 58′
40° 2′	101°	141° 2′	38° 58′	*k* = 101° 00′
				180°

Area $= K = \frac{1}{2}(125.07 \times 80.13 \times \sin 40° 2')$.

log 125.07	=	2.097164
log 80.13	=	1.903795
log sin 40° 2′	=	9.808368
colog 87120	=	−5.059882
log 0.0739	=	−2.869209

log 125.07	=	2.0971
log 80.13	=	1.9037
log sin 40° 2′	=	9.8083
		3.8093
log 43560	=	4.63908
log 0.1479	=	−1.17023

2)0.1479

0.0739 acres

Here it is more convenient to add the colog of 87,120 (43,560 × 2) in place of dividing by 43,560 and afterwards by 2.

In the triangle *jhr* the area is found to be:

$j =$	64°	180°	$h =$	10° 15′	$r =$	64°	$j =$ 49° 58′
	66° 2′	130° 2′		66° 2′		10° 15′	$h =$ 76° 17′
	130° 2′	49° 58′		76° 17′		53° 45′	$r =$ 53° 45′
							180° 00′

$$\text{Area} = K = \tfrac{1}{2}\left(\frac{(125.07)^2 \times \sin 76° 17' \times \sin 49° 58'}{\sin 53° 45'}\right)$$

log 125.07	=	2.097164
log to square	=	2.097164
log sin 76° 17′	=	9.987434
log sin 49° 58′	=	9.884042
colog sin 53° 45′	=	0.093425
colog 87120	=	−5.059882
log 0.1656	=	−1.219111

log 125.07	=	2.097164
log to square	=	2.097164
log sin 76° 17′	=	9.987434
log sin 49° 58′	=	9.884042
		4.065804
log sin 53° 45′	=	9.906575
		4.159229
log 43560	=	4.639088
log 0.3313	=	−1.52014

2)0.3313

0.1656 acres

0.0739 acres

Total area *jkhr* = 0.2395 acres.

Another way of calculating the quadrilateral *jkhr* is as follows: We first figure the triangle *kk'h* in which, as we *have seen* above, we have *kh* = 81.94.

$k =$	75°	180°	$k' =$	10° 15′	$h =$	75°	$k' =$ 79°
	26°	101°		26°		10° 15′	$k' =$ 36° 15′
	101°	79°		36° 15′		64° 45′	$k' =$ 64° 45′
							180° 00′

$\sin 36° 15′ : 81.94 = \sin 64° 45′ : ?$

$$\text{Area} = K = \tfrac{1}{2}\left(\frac{(81.94)^2 \times \sin 79° \times \sin 64° 45′}{\sin 36° 15′}\right)$$

log 81.94	=	1.913496
log to square	=	1.913496
log sin 79°	=	9.991947
log sin 64° 45′	=	9.956387
colog sin 36° 15′	=	0.228185
colog 87120	=	−5.059882
log 0.115	=	−1.063393

0.115 = area $kk'h$

log 81.94	=	1.913496
log sin 64° 45′	=	9.956387
colog sin 36° 15′	=	0.228185
log 125.35	=	2.098068

$jk = 80.13$
$kk' = 125.35$
$jk' = 205.48$

For the triangle $jk'r$ we thus have the base from which we figure the area.

log 205.48	=	2.312769
log tan 36° 15′	=	9.865240
log 205.48	=	2.312769
colog 87120	=	−5.059882
log 0.355	=	−1.550660

area $jk'r$ = 0.355 acre
area $kk'h$ = 0.115 acre
area $jkhr$ = 0.240 acre

This result checks the first method and gives another method which frequently has to be used.

Conflict With Sur. No. 12716

Taking next our conflict with Sur. No. 12716, we figure the missing course from Cor. No. 4, Sur. No. 17846, to

Cor. No. 2, Sur. No. 12716, using our tie made on the ground from No. 8. We assume that we have found the boundaries of Sur. No. 12716 to be correct.

Station.	Course.	Dist.	N. lat.	S. lat.	E. d'p.	W. d'p.
4-17846 — No. 9.....	S. 15° E.	150.00	.....	144.88	38.82	.....
No. 9 — No. 8.....	S. 75 W.	458.00	.....	118.54	.....	442.39
No. 8 — 2-12716.....	N. 40 32′ W.	62.3	47.35	.....	.....	40.48
			47.35	263.42	38.82	482.87
				47.35		38.82
				216.07		444.05

log 216.07 = 2.334595
log 444.05 = 2.647432
log cot 64° 03′ = 9.687163

log 444.05 2.647432
log sin 64° 03′ = 9.953845
log 493.84 = 2.693587

Course S. 64° 03′ W. 493.84 feet.

64° 03′

400.0	= 175.04	359.67
93.0	= 40.69	83.62
0.84	= 0.36	0.75
To check	216.09	444.04

The triangles *wxz* and *wxy* may be worked at the same time, and the triangle *yzx* afterwards calculated as a check and for area.

$w = 75°$
$64° 03′$
$10° 57′$

$x = 64° 03′$
$51°$
$13° 03′$

$y = 51°$
$90°$
$15°\ (90° - 75°)$
$156°$

$w = 10° 57′$
$x = 13° 03′$
$y = 156°$
$180° 00′$

$z = 75°$ $180°$
$39°$ $114°$
$114°$ $66°$

$x = 64° 03′$
$39°$
$103° 03′$

$w = 10° 57′$
$z = 66°$
$x = 103° 03′$
$180° 00′$

sin 156° : 493.84 = sin 10° 57′ : ?
sin 156° : 493.84 = sin 13° 03′ : ?

sin 66° : 493.84 = sin 10° 57′ : ?
sin 66° : 493.84 = sin 103° 03′ : ?

log 493.84	= 2.693587	log 493.84	= 2.693587
log sin 10° 57′	= 9.278644	log sin 13° 03′	= 9.353726
colog sin 156°	= 0.390687	colog sin 156°	= 0.390687
log 230.63	= 2.362918	log 274.16	= 2.438000
log 493.84	= 2.693587	log 493.84	= 2.693587
log sin 10° 57′	= 9.278644	log sin 103° 03′	= 9.988636
colog sin 66°	= 0.039270	colog sin 66°	= 0.039270
log 102.68	= 2.011501	log 526.61	= 2.721493

In the right triangle *yzx* we have from above *zx* = 102.68.

log 102.68	= 2.011501	log 102.68	= 2.011501
log tan 66°	= 10.351417	log cos 66°	= 9.609313
log 230.63	= 2.362918	log 252.47	= 2.402188

To check

274.16
252.47
526.63

log 102.68	= 2.011501
log 230.63	= 2.362918
colog 87120	= −5.059882
log 0.2718	= −1.434301
0.2718	= area *yzx*

Conflict With Sur. No. 1462

In the case of the conflict with Sur. No. 1462, no corners, bearing trees, or bearing rocks could be found, neither could the discovery shaft be identified. The conflict, therefore, must be figured according to its patented or descriptive position and from its section tie. This patented position of Sur. No. 1462 may or may not be its true position, depending on the accuracy of the section tie. In this case a traverse is made from Cor. No. 1, Sur. No. 1462, to section corner (by means of its section tie), thence by section tie to Cor. No. 1, Sur. No. 17846, thence along lines 1–4 and

4–3, Sur. No. 17846, thence by missing course to Cor. No. 1, Sur. No. 1462.

Station.	Course.	Dist.	N. lat.	S. lat.	E. d'p.	W. d'p.
1-1462 — Sec. Cor.....	N. 87° 14′ W.	2006.4	96.85	.....	.....	2004.06
Sec. Cor. — 1-17846....	S. 77 58 W.	618.49	.....	128.89	604.90	.....
1 — 2-17846.....	N. 75 E.	1500.00	388.23	.....	1448.85	.....
2 — 3-17846.....	S. 15 E.	300.00	.....	289.78	77.64	.....
			485.08	418.67	2131.39	2004.06
			418.67		2004.06	
			66.41		127.33	

log 66.41 = 1.822233
log 127.33 = 2.104928
log cot 62° 27′ = 9.717305

log 127.33 = 2.104928
log sin 62° 27′ = 9.947731
log 143.61 = 2.157197

Course S. 62° 27′ W. 143.61 feet.

62° 27′

100.0	= 46.25	88.66
43.0	= 19.89	38.12
0.61	= 0.28	0.54
To check	66.42	127.32

From this the triangles *ust* and *vst* are figured.

$v = 32°$ $15°$ $47°$ — $s = 62°\ 27'$ $32°\ 00'$ $30°\ 27'$ — $t = 15°$ $62°\ 27'$ $77°\ 27'$ — $180°$ $77°\ 27'$ $102°\ 33'$

$v = 47°$
$s = 30°\ 27'$
$t = 102°\ 33'$
$180°\ 00'$

$u = 75°$ $43°$ $137°$ — $180°$ $43°$ $137°$ — $t = 75°$ $62°\ 27'$ $12°\ 33'$

$u = 137°$
$t = 12°\ 33'$
$s = 30°\ 27'$
$180°\ 00'$

sin 137° : 143.61 = sin 30° 27′ : ?
sin 137° : 143.61 = sin 12° 33′ : ?
sin 43° : 143.61 = sin 102° 33′ : ?
sin 43° : 143.61 = sin 30° 27′ : ?

log 143.61 = 2.157197
log sin 30° 27′ = 9.704825
colog sin 137° = 0.166217

log 106.74 = 2.028239

log 143.61 = 2.157197
log sin 102° 33′ = 9.989497
colog sin 47° = 0.135873

log 191.67 = 2.282567

log 143.61 = 2.157197
log sin 12° 33′ = 9.337043
colog sin 137° = 0.166217

log 45.76 = 1.660457

log 143.61 = 2.157197
log sin 30° 27′ = 9.704825
colog sin 47° = 0.135873

log 99.52 = 1.997895

In triangle *utv* we have:

log 106.74 = 2.028239
log tan 43° = 9.969656

log 99.52 = 1.997895

log 106.74 = 2.028239
log cos 43° = 9.864127

log 145.92 = 2.164112

log 106.74 = 2.028239
log 99.52 = 1.997895
colog 87120 = −5.059882

log 0.1219 = −1.086016

To check 145.92 = *uv*
45.76 = *su*

191.68 = *sv*

0.1219 acre = area triangle *utv*.

Conflict With Sur. No. 17560

For Sur. No. 17560 we first find the course and distance from Cor. No. 3, Sur. No. 17846, to Cor. No. 4, Sur. No. 17560, as follows:

Station.	Course.	Dist.	N. lat.	S. lat.	E. d'p.	W. d'p.
4–17650 — No. 8.....	N. 45° 10′ W.	149.5	105.40	.....	.....	106.02
No. 8 — No. 9.....	N. 75 E.	458.00	118.55	.....	442.39	.....
No. 9 — 3–17560.....	S. 15 E.	150.00	.....	144.88	38.82	.....
			223.95	144.88	481.21	106.02
			144.88		106.02	
			79.07		375.19	

log 79.07 = 1.898012
log 375.19 = 2.574251
log cot 78° 06′ = 9.323761

log 375.19 = 2.574251
log sin 78° 06′ = 9.990565
log 383.43 = 2.583686

S. 78° 6′ W. 383.43 = course
78° 6′

300.0 = 61.86	293.55
83.0 = 17.11	81.21
0.43 = 0.08	0.42
79.05	375.18

For the triangle *ABt*:

$A = 75° 00′$
$34° 08′$
$40° 52′$

$B = 180° 00′$
$78° 06′$
$101° 54′$
$34° 08′$
$136° 02′$

$t = 78° 06′$
$75° 00′$
$3° 06′$

$A = 40° 52′$
$B = 136° 02′$
$t = 3° 06′$
$180° 00′$

sin 40° 52′ : 383.43 = sin 136° 02′ : ?
sin 40° 52′ : 383.43 = sin 3° 06′ : ?

log 383.43 = 2.583686
log sin 136° 02′ = 9.841509
colog sin 40° 52′ = 0.184222
log 406.83 = 2.609417

log 383.43 = 2.583686
log sin 3° 06′ = 8.733027
colog sin 40° 52′ = 0.184222
log 31.69 = 1.500935

For the triangle *DAE*:

$D = 75° 00′$
$75° 45′$
$150° 45′$

$180° 00′$
$150° 45′$
$29° 15′$

318.98 = *EB*
31.69 = *BA*
287.29 = *EA*

$A = 75° 00′$
$34° 08′$
$40° 52′$

$E = 34° 08′$
$75° 45′$
$109° 53′$

$D = 29° 15′$
$A = 40° 52′$
$E = 109° 53′$
$180° 00′$

sin 29° 15′ : 287.29 = sin 109° 53′ : ?
sin 29° 15′ : 287.29 = sin 40° 52′ : ?

log 287.29 = 2.458320
log sin 109° 53′ = 9.973307
colog sin 29° 15′ = 0.311028
log 552.91 = 2.742655

log 287.29 = 2.458320
log sin 40° 52′ = 9.815778
colog sin 29° 15′ = 0.311028
log 384.70 = 2.585126

In order to ascertain the intersection of line 6–1, Sur. No. 17560, and line 4–1, Sur. No. 17846, prolong line 6–1, Sur. No. 17560, with dotted lines, until it touches line 2–3, Sur. No. 17846. Thus we have the traingle *GDF*, of which we have the side *GD*, as follows:

500.00 = 5–6–17560
384.70 = *DE*

115.30 = *GD*

$G = 75° 45'$ $D = 75° 45'$ $180° 00'$ $F = 75° 00'$ $G = 39° 45'$
$36° 00'$ $75° 00'$ $150° 45'$ $36° 00'$ $D = 29° 15'$
$F = 111° 00'$
$39° 45'$ $150° 45'$ $29° 15'$ $111° 00'$ $180° 00'$

sin 111° : 115.30 = sin 39° 45′ : ?
sin 111° : 115.30 = sin 29° 15′ : ?

log 115.30	= 2.061829	log 115.30	= 2.061829
log sin 39° 45′	= 9.805799	log sin 29° 15′	= 9.688972
colog sin 111°	= 0.029848	colog sin 111°	= 0.029848
log 78.97	= 1.897476	log 60.35	= 1.780649

In the right triangle *JFH* 36° − 15′ = 21°, *JH* = 300 ft.,

nat tan 21° = 0.38386	nat secant 21° = 1.071145
300	300
115.158	321.3435

321.34 = *JF*
60.35 = *GF*

260.99 = *JG* = Cor. No. 6–17560 to line 4–1–17846.

In figuring the triangle *ABt* we find Cor. No. 2–17846 to *A* = 1,500

406.83 = *At*

1093.17 = 2–17846–*A*

From Cor. No. 2–17846 to *D* we have:

1093.17 = 2–17846–*A*
552.91 = *DA*

540.26 = 2.17846–*D*

In the triangle *GDF* we find *FD*, and in the triangle *JHF* we find *HF*:

FD = 78.97
HF = 115 15
HD = 194.12

Cor. No. 2–17846 to *D* = 540.26
HD = 194.12
Cor. No. 2–17846–*H* = 346.14 =
Cor. No. 1–17846 to line 6–1–17560.

In the triangle *JKL*, line *JK* is drawn parallel to line 1–2–17560.

J = 75° 00′ / 34° 08′ / 40° 52′
K = 34° 08′ / 36° 00′ / 70° 08′
L = 36° 00′ / 75° 00′ / 111° 00′ / 180° / 69°

J = 40° 52′
K = 70° 08′
L = 69° 00′
180° 00′

sin 69° : 318.98 = sin 40° 52′ : ?
sin 69° : 318.98 = sin 70° 08′ : ?

log 318.98 = 2.503764
log sin 40° 52′ = 9.815778
colog sin 69° = 0.029848
log 223.55 = 2.349390

log 318.98 = 2.503764
log sin 70° 08′ = 9.973352
colog sin 69° = 0.029848
log 321.34 = 2.506964

1000.00 = 6–1–Sur. No. 17560.
260.99 = *JG*
739.01 = 1–Sur. No. 17560 to 1–4–Sur. No. 17846.
223.55 = *KL*
962.56 = 2–Sur. No. 17560 to 1–4–Sur. No. 17846
346.14 = 1–Sur. No. 17846 to line 6–1–Sur. No. 17560.
321.34 = *JL*
667.48 = 1–Sur. No. 17486 to line 2–3–Sur. No. 17560.

1000.0
962.56
37.44 = 3–Sur. No. 17560 to line 4–1–Sur. No. 17846.

Areas of Sur. No. 17560.

first figure the area of the trapezoid JL 3 6 and the

parallelogram represented by Cors. Nos. 3, 4, 5 and 6 of Sur. No. 17560.

260.99 = *J* 6
37.44 = *L* 3

2)298.43
149.21

500
300

150000 = 5.176091
colog 43560 = −5.360912

log 3.443 = 0.537003

log 149.21 = 2.173798
log 300 = 2.477121
colog 43560 = −5.360912

log 1.027 = 0.011831

Area for the triangle *DAE*

log 552.91 = 2.742655
log 287.29 = 2.458320
log sin 40° 52′ = 9.815778
colog 87120 = −5.059882

log 1.193 = 0.076635

1.027
3.443

4.470
1.193

3.277 = Total area in conflict between Surs. Nos. 17846 and 17560.

To find the area in conflict between Sur. No. 16591 and Sur. No. 17560 within Sur. No. 17846, we figure the area of the triangle *JeN*.

J =	75°	180°
	36°	111°
	111°	69°

e = 75° 00′
10° 15′
64° 45′

N = 36° 00′
10° 15′
46° 15′

J = 69°
e = 64° 45′
N = 46° 15′
180° 00′

624.77 = 1–Sur. No. 17846 — 2–3–16591.
346.14 = 1–Sur. No. 17846 — 6–1–17560.

278.63 = *Je*
sin 46° 15′ : 278.63 = sin 64° 45′ : ?
log 278.63 = 2.445028
log sin 64° 45′ = 9.956387
colog sin 46° 15′ = 0.141244

log 348.87 = 2.542659

log 278.63 = 2.445028
log sin 69° = 9.970151
log 348.87 = 2.542659
colog 87120 = 5.059882

log 1.041 = 0.017

In the triangle *GNM*

348.87 = *JN*	*G* = 75° 45′	*N* = 36° 00′	*M* = 75° 45′	180°
260.99 = *JG*	36° 00′	10° 15′	10° 15′	86°
87.88 = *GN*	39° 45′	46° 15′	86° 00′	94°

G = 39° 45′
N = 46° 15′
M = 94° 00′
180° 00′

$$\text{Area} = \tfrac{1}{2}\left(\frac{(87.88)^2 \times \sin 39° 45' \times \sin 46° 15'}{\sin 94°}\right)$$

log 87.88	= 1.943890	
log to square	= 1.943890	1.041 = area *JeN*.
log sin 39° 45′	= 9.805799	0.041 = area *GMN*.
log sin 46° 15′	= 9.858756	
colog sin 94°	= 0.001059	1.000 = net area in conflict of Surs. Nos. 17560 and 16591 within Sur. No. 17846.
colog 87120	= −5.059882	
log 0.0410	= −2.613276	

We now figure the area in conflict of Sur. No. 17560 and Sur. No. 17541 within Sur. No. 17846 which is *QopDG*.

By previous work we have found the total conflict of Sur. No. 17541 and Sur. No. 17846 to be .752 acres. We have also found the area of the quadrilateral *jrhk* to be .240 acres. We must now find the area of *QrMG*. In order to figure the area of the triangle *QrN* it is necessary to find the length of one side, which we will take to be *rN*. In previous figuring the area of the triangle *jrh* was obtained and from the data used in that work we find the side *rh* as follows:

j = 64° 00′	180° 00′	*r* = 64° 00′	*h* = 10° 15′
66° 02′	130° 02′	10° 15′	66° 02′
130° 02′	49° 58′	53° 45′	76° 17′

sin 53° 45′ : 125.07 = sin 49° 58′ : ?

log 125.07	= 2.097164	j = 49° 58′
log sin 49° 58′	= 9.884042	r = 53° 45′
colog sin 53° 45′	= 0.093425	h = 76° 17′
log 118.75	= 2.074631	180° 00′

In the small triangle FhN we must obtain the side hN. We have the side Fh, as follows:

483.29 = 2–Sur. No. 17846 to line 2–3, Sur. No. 16591.
461.29 = 2–Sur. No. 17846 to F.

22.00 = Fh.

				F = 69° 00′
F = 75°	180°	h = 75° 00′	N = 36° 00′	h = 64° 45′
36°	111°	10° 15′	10° 15′	N = 46° 15′
111°	69°	64° 45′	46° 15′	180° 00′

Sin 46° 15′ : 22.00 = sin 69° : ?

log 22.00	= 1.342423	Nh = 28.44
log sin 69°	= 9.970152	hr = 118.75
colog sin 46° 15′	= 0.141244	rN = 147.19
log 28.44	= 1.453819	

r = 64° 00′	N = 10° 15′	Q = 64°	180°	r = 53° 45′
10° 15′	36° 00′	36°	100°	N = 46° 15′
53° 45′	46° 15′	100°	80°	Q = 80° 00′
				180° 00′

$$\text{Area triangle } QrN = \tfrac{1}{2}\left(\frac{(147.19)^2 \times \sin 53° 45' \times \sin 46° 15'}{\sin 80° 00'}\right)$$

log 147.19	= 2.167878
log to square	= 2.167878
log sin 53° 45′	= 9.906575
log sin 46° 15′	= 9.858756
colog sin 80°	= −0.006649
colog 87120	= −5.059882
log 0.1471	= −1.167618

Subtracting from this the area of triangle GMN, found in previous work to be .0410 acre, we have:

0.1471
0.0410

0.1061 acre = QrMG.

In the small triangle *hMD*, we have *hD* =

540.26 = 2–17846 to *D*
483.29 = 2–17846 to *h*

56.97 = *hD*

h =	75° 00′	*M* =	75° 45′	*D* =	75° 45′	180° 00′	*h* = 64° 45′
	10° 15′		10° 15′		75° 00′	150° 45′	*M* = 86° 00′
							D = 29° 15′
	64° 45′		86° 00′		150° 45′	29° 15′	180° 00′

$$\text{Area} = \tfrac{1}{2}\left(\frac{(56.97)^2 \times \sin 64° 45' \times \sin 29° 15'}{\sin 86°}\right)$$

log 56.97	=	1.755646
log to square	=	1.755646
sin 64° 45′	=	9.956387
sin 29° 15′	=	9.688972
colog sin 86°	=	0.001059
colog 87120	=	−5.059882
log 0.0165	=	−2.217592

0.752 = area *jkop*
0.240 = area *jrhk*

0.512 = area *rhop*
0.016 = area *hMD*

0.496 = area *ropDM*
0.106 = area *QrMG*

0.602 = area *QopDG*

We therefore have found the total area in conflict of Sur. No. 17846 and Sur. No. 17560 to be 3.277 acres.

The net area in conflict of Surs. Nos. 17560 and 16591 within Sur. No. 17846 to be 1.000 acre.

The total conflict of Surs. Nos. 17560 and 17541 within Sur. No. 17846 to be .602 acre, and the net conflict of Surs. Nos. 17560 and 17541, within Sur. No. 17846 (that is, exclusive of *QrMG*, .106 acre) to be .496 acre.

Therefore, the net conflict of Surs. Nos. 17560 and 17846 is:

1.000 acre = *JeMG*	3.277 acres
0.496 acre = *ropDM*	1.496 acres
1.496 acres	1.781 acres, net conflict.

The result may be checked by double meridian distances *as follows:*

Station.	Course.	Distance.	Latitudes.		Departures.		Double M. D.	N. areas.	S. areas.
			N.	S.	E.	W.			
B–A.....	S. 34° 08′ W.	31.69	.....	26.23	.....	17.78	17.78	.....	466.37
A–p.....	S. 75 00 W.	386.22	.....	99.96	.....	373.06	408.62	.....	40845.65
p–o.....	N. 26 00 W.	138.44	124.43	.....	.....	60.68	842.36	104814.08	.....
o–r.....	S. 64 00 W.	149.33	.....	65.47	.....	134.23	1037.27	.....	67910.06
r–e.....	N. 10 15 E.	212.94	209.54	.....	37.89	.....	1133.61	237536.56	.....
e–L.....	N. 75 00 E.	42.71	11.05	.....	41.25	.....	1054.47	11651.90	.....
L–3.....	S. 36 00 E.	37.44	.....	30.29	22.00	.....	991.22	.....	30024.05
3–B.....	S. 75 45 E.	500.00	.....	123.07	484.61	.....	484.61	.....	59641.00
			345.02	345.02	585.75	585.75		354002.54 198887.13	198887.13
								2) 155115.41	
								77557.7	sq. ft.

log 77557.7 = 5.8896249
log 43560.0 = 4.6390879

log 1.780 = 1.2505370

The area statement for Sur. No. 17846 would be as follows:

	Acres
Total area Sur. No. 17846	10.330
Area in conflict with —	
Sur. No. 1462	0.122
Sur. No. 12716	0.272
Sur. No. 16591	2.284
Sur. No. 17541	0.752
Sur. No. 17541 (exclusive of its conflict with Sur. No. 16591)	0.513
Sur. No. 17560	3.277
Sur. No. 17560 (exclusive of its conflict with Sur. No. 16591)	2.277
Sur. No. 17560 (exclusive of its conflict with Sur. No. 17541)	2.675
Sur No. 17560 (exclusive of its conflict with Surs. Nos. 16591 and 17541)	1.781

The following net area statement is not at present included in the field notes sent to the surveyor general, but is filed on separate sheet.

		Acres
Total area Sur. No. 17846		10.330
Less area in conflict with —		
Sur. No. 1462	0.122	
Sur. No. 12716	0.272	
Sur. No. 16591	2.284	
Sur. No. 17541	0.513	
Sur. No. 17560	1.781 =	4.972
Net area lode claim		5.358

In case of an irregular mill site or placer the calculations of the area by double meridian distances must be handed in with the field notes. The calculations have been taken up under mill sites and placers.

It is well to be systematic in making and filing the above calculations. Many prefer books of uniform size, but it is very difficult for more than one person to work on the same case at the same time and keep the calculations together in the same book. It is also difficult to copy from

one page to another as is often necessary. The writer prefers to use traverse blanks printed and blocked. On these the traverse is first worked and the triangles and areas figured underneath on the same sheet. These sheets are then filed in Congress manila envelopes in document files. In this way any number of people may work on the same case without getting into each other's way. The papers of each survey are kept together in order, and all useless figuring and any calculations found to be in error are destroyed and do not encumber the record.

Miscellaneous Points on Patents

Various points may arise in figuring or writing up the notes that need attention. For example, it frequently happens that by excluding areas in the usual way a discovery shaft is excluded. To avoid this, a tract is made around the discovery shaft, and one corner of the tract is tied to a corner of the claim, and the tract described by metes and

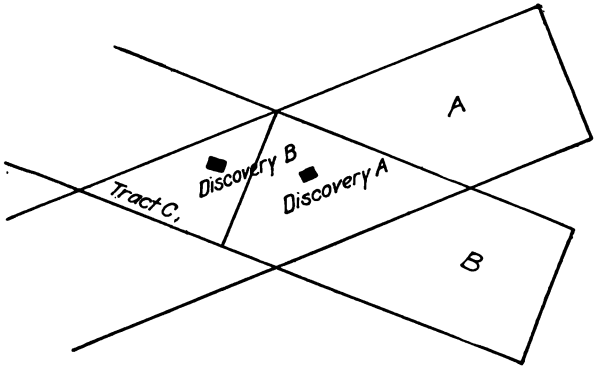


Fig. 39

bounds. In Fig. 39, if either *A* or *B* excludes the other, they respectively exclude their discovery shafts. To avoid this the conflict is described as follows:

	Acres
Total area A lode	5.165
Area in conflict with	
Tract C (hereinafter described)	0.310
B lode of this survey	1.340
B lode of this survey (exclusive of its conflict with tract C	1.330

The following net area statement is not at present included in the field notes sent to the surveyor general, but is filed on separate sheet.

	Acres
Total area A lode	5.165
Less area in conflict with tract C	0.310
Net area A lode	4.855

This tracting of the discovery is useful sometimes in conflict with a location survey. If *A* above is a location survey, a small tract, just large enough, may be made round the discovery shaft of *B* and not excluded with the remainder of the conflict of *A* with *B*. This small reservation, which may not be over ten feet square, is usually not objected to by the owner of the location, and might even be deeded back to him after the patent is issued.

During the period when conflicts were figured in the descriptive positions by their section ties, as stated before, tracts were frequently employed to exclude the conflicting claim or claims in their true positions. Thus, when figuring the position from the section ties showed no conflict, but the corners on the ground clearly showed a conflict, this was excluded as a tract. Tracts are frequently employed to exclude any desired area other than that embraced in an officially surveyed claim.

In case the discovery is unavoidably excluded the claim may still be patented according to the present rulings of the general land office by producing proofs that there is a

valid discovery of mineral at some other point on the center line not excluded.

Here it may be observed that for about five years between June, 1899, and August, 1904, the General Land Office required all claims to be figured according to their patented positions, as we have figured Sur. No. 1462, regardless of the existence or position of the monuments on the ground. As the section ties of many claims varied from a few feet to many thousand feet from the correct distance, the official plats issued during the period mentioned above often give a very erroneous idea of the conditions actually existing on the ground. The surveyor dealing with claims surveyed within the time mentioned must bear clearly in mind the conditions under which the surveys were made.

In case errors are found in the surveying and description of conflicts, the conflicting claim must be platted and figured as actually found on the ground, and a note added to the field notes filed with the surveyor general's office about as follows:

I find the following errors in the lines of former approved surveys:

Sur. No. 16162, Alice Lode:

Line 1–2, S. 16° 10′ W. 147.8 ft. instead of S. 16° 50′ W. 150 ft., as approved.

Line 2–3, S. 73° 50′ W. 1,406 ft. instead of S. 73° 10′ W. 1,500 ft., as approved, etc.

The mineral surveyor who made the conflicting survey which is found to be in error then files amended notes covering the errors in question. In case he does not admit that there is an error, a joint survey is called for at the expense of the one who is found to be wrong.

Mineral surveyors, however, rarely require an offic

joint survey to settle their differences, and disagreements are, as a rule, arranged privately and the reports made in accordance with the facts. Here it must be remembered that an error of one in two thousand, or about two minutes in course is allowed by the surveyor general. Thus it is evident that two surveyors may differ from each other one in one thousand, or three minutes in course, and yet each be within the limit of allowable error.

All the intersections and areas having been figured for the claim, a plat is made on tracing cloth, on the dull side, and the notes are written up as in the example of field notes given later.

In case the claim has been narrowed on one side, so that the vein, and therefore the discovery, is not in the center of the claim, a tie must be given to it from some corner of the claim.

Claims are frequently cut short when, on account of conflicts, no acreage is obtained by patenting the full length. This of course often reduces the amount of figuring necessary, but it is sometimes objected to by the claimant, as he frequently thinks it desirable to be able to state that he has a claim 1,500 feet long, even if it gives him no more acreage than if the claim were only 800 feet in length and on clear ground. It must here be remembered that for many years the General Land Office required all claims either to cross a conflicting claim completely with the center line, or else cut off the claim at the point where the center line intersected the boundary lines of the conflicting claim. In fact, for a brief period no crossings at all were allowed by the General Land Office.

In case the claim has been cut off for any reason, a tie *must* be given in every case from the corner set to the *original* corner of the location.

It is sometimes advisable in very complicated cases to write up the notes in advance of the actual figuring, leaving blank spaces, which are filled systematically as the calculations proceed. In this way repetitions and omissions are avoided.

In the matter of improvements, the so-called "$500 worth of work," the Land Office is constantly changing its opinion. For many years $500 worth of work sufficed for a whole group of locations, no matter how many, provided that the work was done for their common benefit. This was in accordance with a decision of the Supreme Court of the United States, which regarded a group of locations as one claim. At present $500 worth of work is required for each claim, though it need not necessarily be on each claim. A tunnel can thus be used to patent a whole group, provided there is $500 worth of work which can be shown to be for the benefit of each location, or a total of as many dollars as there are locations in the group multiplied by $500. In case this mutual benefit cannot be shown for certain locations, other work must be in evidence. It cannot be too strongly stated that the utmost care must be taken by the mineral surveyor in preparing his mutual benefit statement to bring out strongly the fact of the mutual benefit of the improvements in the event that there is not actually $500 worth of work on each claim. Neglect of this has caused a great deal of trouble in the subsequent dealings with the General Land Office. When the claim being patented is contiguous to a patented claim belonging to the same claimant, work done on the patented claim may apply towards the $500 worth of improvements, provided the work has never been used in patenting any other claim, and also provided that it can be shown to be of benefit for the claim in question, and both these facts must be stated in the fie

notes. This can be done only when the claims are contiguous, and under the same ownership or, when not contiguous, in the case of a tunnel, when the work is actually under the claims being patented.

All of the improvements need not be used in patenting if there is a possibility of their being used later on for other claims as $500 expenditure. Where there is a chance of this in the future it is well to claim only enough improvements necessary to patent the claim in question. But it must be remembered that all improvements must be subsequent to the date of location of the claims which are thus benefited. (See 39 of the manual.)

At the time the survey is approved the required $500 for each location may not have been completed, or it may happen that more improvements are required at a later date by the General Land Office. In this case, the surveyor makes a supplementary affidavit of labor. This is made on a form furnished by the surveyor general's office, and the surveyor repeats or revises all the data given in the approved field notes, and then adds the description of the new work. He also states, as is required, that the work was completed before the period of advertising expired. For this affidavit the surveyor general requires an additional fee.

Should it be desired to take the whole or any portion of a piece of ground that has been surveyed and advertised for patent, though no patent has actually issued, it is usually necessary to have the application for this claim cancelled before the ground or any portion of it can be included in a later application.

The surveyor must be careful, in the case of mill sites, to see that it is clearly shown that they are used for mining purposes and not merely to take up land or water.

They may legitimately contain mills and reduction works, dumps, necessary roads, cabins, storehouses, etc., actually used in connection with mining operations, and the fact must in each case be clearly shown.

It will be well, in the case of a survey of any claims or group of claims that are at all out of the ordinary, to find out, from the surveyor general having jurisdiction, just what is the proper procedure in the particular case in question. In this way future troubles may often be avoided.

Adverses and Protests

In surveys for adverse, the claim adversing is tied to the official survey adversed exactly as described in previous sections, and the area in conflict figured in the same way. Improvements should be also noted as in patent surveys. The net area in conflict is then described by metes and bounds and this description had best be traversed carefully to make sure of a closure. An adverse plat is finally prepared, usually on a scale of 200 feet to the inch, on tracing cloth and the area in conflict colored. The mineral surveyor signs a statement as follows:

I hereby certify that the above diagram correctly represents the conflict claimed to exist between the Little Annie lode and the Belle lode as actually surveyed by me. And I further certify that the value of the labor and improvements on the Little Annie lode made by the adverse claimant (and his grantors) is not less than one hundred dollars.

JOHN SMITH,
United States Mineral Surveyor.

When there is not time to figure the conflict completely, the adverse plat may be filed with the ties and boundaries

of the conflicting claims, and the improvements of the claim adversing, and the complete description may be sent in later. In case it is impossible to make the adverse survey, as, for example, on account of deep snow, the best statement possible of the facts should be made at once and a proper survey made later. The attorney for the claimant prepares all the papers in an adverse suit, as well as in a protest suit, which latter, from the standpoint of the surveyor, is practically the same as an adverse suit. The surveyor simply supplies the attorney with the plat and the description of the conflict.

The mineral surveyor who is surveying claims for patent should avoid all possible cause for adverse or protest proceedings by leaving out all ground clearly belonging to others. In spite of his best efforts, his claims will occasionally be adversed and his advice may be called for in connection with the settlement of the case, or he may be cited as a witness. Should the case be fought to a finish in the courts, he has no influence. In case of a compromise, by which the claimant patenting loses the area in conflict or any portion of it, the simplest solution is usually to deed this area to the contestant after the receiver's receipt is issued. In case the area is simply left out in the final application to purchase, the Land Office will call for an amended plat at some later date, with attendant delay and expense. The amended plat will be called for in any case where any area is excluded in the final application to purchase, and is not shown in the field notes approved by the surveyor general. While this is all part of the attorney's work, and really has nothing to do with the actual surveying, it is well for the surveyor to keep in mind the probable subsequent actions of the General Land Office, *in order to* provide for the best interests of his clients.

CHAPTER VI

PATENT FIELD NOTES

SPECIMEN FIELD NOTES AND FORMS

The following field notes and forms represent the present practise. See Plate III.

(4—689)

Application to United States Surveyor General for Survey of Mining Claims

....., ...

....., 19...

United States Surveyor General,

.....

Sir: ....., claimant.., hereby make.. application for an official survey, under the provisions of chapter 6, title 32, of the Revised Statutes of the United States, and regulations and instructions thereunder, of the mining claim known as the ....., situate in ..... mining district, ... county, ..., in section ....., township No. ....., range No. ..... Said claim is based upon a valid location made on ....., 19..., and duly recorded on ....., 19..., and is fully described in the duly certified copy of the record of the location certificate, filed herewith. Said certificate contains the name of the locator, the date of location, and such a definite description of the claim by reference to natural objects or permanent monuments as will identify the claim, and said location has been distinctly marked by monuments on the ground, so that its boundaries can be readily traced.

..... request that you will send ..... an estimate of the amount required to defray the expenses of platting and other work in your office, required under the regulations, that ..... may make proper deposit therefor, and that thereupon you will cause the survey to be made by ....., United States mineral surveyor, and proper action to be taken thereon by your office, as required by the United States mining laws and regulations thereunder.

..... Claimant.

P. O. Address, ...

(4—682)

Order for Mineral Survey

DEPARTMENT OF THE INTERIOR,

Office of the Surveyor General,

.....,

....., 19...

To .....,

U. S. Mineral Surveyor,

.....

Sir: Application has been filed in this office by ..... dated ....., to ....., for an official survey of the mining claim of ....., known as the ....., situate in ..... mining district, ... county, in section ....., township No. ....., range No. ....., which claim is based upon a location made on ....., 19..., and duly recorded on ....., 19..., and is fully described in the duly certified copy of the record of the location certificate, filed by the applicant.. for said survey, a copy of which is herewith inclosed. You are hereby directed to make the survey of said claim in strict conformity with existing laws, official regulations, and instructions thereunder, and to make proper return to this office. Said survey will be designated as Survey No. .....

Very respectfully,

.....,

U. S. Surveyor General for.....

Sur No.	*Date of Order*
APPLICATION TO U. S. SURVEYOR GENERAL FOR SURVEY OF MINING CLAIM KNOWN AS THE	
.....	
.....	
.....	

MEMO. OF DEPOSIT

Depositor:.....

C. D. No..... *Date*.....

Bank:.....

Amount: $.....

REMARKS

.....

.....

ESTIMATES OF OFFICE COSTS

For Lode Claim.....	$30.00
For Placer Claim.....	35.00

For Mill Site	30.00
For Mill Site included in one survey with a Lode Claim	20.00
For each Lode Claim within and included in the survey of a Placer Claim	20.00
For several Lode locations included in one survey, first location named	30.00
All other locations named, each	25.00
For several Placer locations included in one survey, the first location named	35.00
All other locations named, each	30.00
For Certificate of $500. Expenditure of improvements after approval of survey	5.00

Instructions

The foregoing estimates represent the average office experience. If insufficient in any case to defray the actual office cost, a further estimated deposit will be called for; if excessive, a refund of unearned portion is authorized by law. See Act of Congress approved February 24, 1909, 35 Stat. 645.

Applicants are requested to mention in one application the name or names of the locations constituting the entire claim for which they desire an official survey, and are advised that several locations can be embraced in a single survey only when the same are contiguous — i.e., conflicting or adjoining.

All applications for mining survey orders should be signed by the claimants, their agents or attorneys. See Par. 1, Circular to Applicants, Page 22, Mineral Manual, 1909. 29 L.D. 718.

U. S. Mineral Surveyors are precluded from acting, either directly or indirectly, as agents or attorneys in proceedings to patent mining claims including the surveys thereof. See Par. 7, Page 7, Mineral Manual of 1909.

APPLICATION TO U. S. SURVEYOR GENERAL FOR SURVEY OF MINING CLAIM

.....

....., 19...

U. S. SURVEYOR GENERAL,
Denver, Colorado.
Sir:

..... claimant .., hereby make .. application for an official survey, under the provisions of Chapter 6, Title 32, of the Revised Statutes of the United States, and regulations and instructions thereunder, of the mining claim known as the .....
.....
.....
located in Sec....., Tp. ....., R. ..... P.M.....
Land District, ... Mining District,
..... National Forest, ... County, Colorado.
Said claim is based upon valid location as fully described in the certified cop ... of the ..... location certificate .., filed herewith, and said location .. ha ... been distinctly marked by monuments on the ground so that the boundaries may be readily traced.

In conformity with estimate furnished, a deposit of $..... to the credit of the Treasurer of the United States has been made at the .....
.....National Bank (U. S. Depository) or ....., ...,
with request that duplicate certificate be forwarded to you.

Send order to.....U. S. Mineral Surveyor,
at....., ...

Very respectfully,

.....
Claimant.

By.....

P. O. Address.....,

..... County .....

DEPARTMENT OF THE INTERIOR *
Office of U. S. Surveyor General,
Denver, Colo., ..., 19...

To.....,
U. S. Mineral Surveyor, District of Colorado
.....

* This form is used for Colorado.

Sir:

You are hereby directed to survey the claim of ....., upon the ....., in ..... Mining District, ... County, Colorado. This survey will be designated "Survey No....., ... Land District," and must be made in strict conformity with the.....

....., U. S. Surveyor General for Colorado.

Mineral Survey No. **21000 A and B**

.....

Denver Land District

FIELD NOTES

of the Survey of the Mining Claim of

TIMOTHY BROWN

known as the

Denver and Boston Lodes and the London Mill Site

Coral Mining District

Clear Creek County, Colorado.

Unsubdivided Township 3 S. and Section 4, Township 4 S., Range 73 W. 6th P. M. Surveyed under instructions dated September 1, 1919

by FRANK JONES,
U. S. Mineral Surveyor.

Claim Located....., 19...
Survey commenced September 5, 1919.
Survey completed October 31, 1919.
Address of claimant, Box 567, Denver, Colorado

Feet.	Survey No. 21000 A.
	Denver Lode
	Beginning at Cor. No. 1.
	A spruce post 5 ft. long, 5 ins. square, set 2 ft. in the ground with mound of stone, scribed cross (X) at corner point and D. 1–21000 A, whence
	The N. E. Cor. Sec. 4 T. 4 S. R. 73 W. 6th P. M. bears S. 19° 30′ E. 309 ft.
	Cor. No. 1, Sur. No. 1685, Paris lode, claimant unknown, bears S. 19° W. 142 ft.
	Position of Cor. No. 4, Sur. No. 1685, Paris lode, bears N. 66° 36′ W. 259.93 ft.
	A corner of the location bears N. 88° 25′ E. 100 ft.
	A cross (X) and B. R. D. 1–21000 A. chiseled 4 ft. above the ground on a granite cliff 20 ft. high bears N. 45° E. 25.3 ft.
	Thence S. 88° 25′ W.
333.02	Intersect line 3–4, Sur No. 1685, Paris lode, at S. 40° W. 146.77 ft. from Cor. No. 4.
770.0	Road, 10 ft. wide, course Southeast and Northwest.
896.67	Cor. No. 6, Boston lode, of this survey.
1400.0	To. Cor. No. 2.
	Identical with a corner of the location.
	A rock in place 6 × 4 × 2 ft. above the general surface, chiseled cross (X) at corner point and D. 2–21000 A.
	Thence N. 1° 35′ W.
85.0	Creek, 4 ft. wide, flows Southwest.
300.0	To Cor. No. 3.
	Identical with position for a corner of the location.
	Not set, as it falls in the center of the creek, 4 ft. wide, flowing Southeasterly, where corner could not be established.
	Thence N. 88° 25′ E.
65.0	Witness Corner to Cor. No. 3.
	A granite stone, 27 × 12 × 8 ins. set 14 ins. in the ground, with mound of stone, chiseled cross (X) at corner point and W. C. D. 3–21000 A, whence
	A pine tree, 8 ins. diam. blazed and scribed B. T. W. C × D. 3–21000 A bears N. 28° E. 15 ft.
250.0	Road, 10 ft. wide, course Southeast and Northwest.
1400.0	To Cor. No. 4.
	A cross (X) at corner point and D. 4–21000 A chiseled on a ledge of rock, whence
	A corner of the location bears N. 88° 25′ E. 100 ft.
	Thence S. 1° 35′ E.

Feet.	Survey No. 21000 A. — Continued.
	Denver Lode. — Continued.
73.17	Intersect line 4–5, Sur. No. 1685, Paris lode, at N. 62° E. 263.08 ft. from Cor. No. 4.
300.0	To Cor. No. 1, the place of beginning.
	Boston Lode
	Beginning at Cor. No. 1. A pine stump hewed to 5 ins. square, scribed cross (X) at corner point and B. 1–21000 A, and surrounded by mound of stones, whence The N. E. Cor. Sec. 4 T. 4 S. R. 73 W. 6th P. M. bears N. 31° 50′ E. 765.82 ft. Cor. No. 2, Sur. No. 1685, Paris lode, bears N. 53° 8′ W. 324.65 ft. Thence S. 35° W.
323.56	To Cor. No. 2. A cross (X) at corner point and B. 2–21000 A chiseled on a boulder 10 × 15 × 6 ft. whence Cor. No. 2 Golden lode, unsurveyed, John Smith, claimant, bears N. 44° 58′ W. 52.61 ft. Thence N. 33° W.
54.80	Intersect line 1–2 Golden lode, unsurveyed, at N. 40° E. 11.40 ft. from Cor. No. 2.
368.51	Intersect line 3–4 Golden lode, unsurveyed, at N. 40° E. 103.12 ft. from Cor. No. 3.
1091.83	Intersect North boundary Sec. 4 at East 1455.83 ft. from the position for the N. ¼ Cor. said section.
1156.44	To Cor. No. 3. A pine tree, 14 ins. diam. blazed and scribed cross (X) at corner point and B. 3–21000 A. Thence N. 55° W.
345.84	To Cor. No. 4. Identical with Cor. No. 2, Denver lode, of this survey. Thence N. 35° E.
300.0	To Cor. No. 5. A granite stone, 29 × 12 × 8 ins. set 15 ins. in the ground with mound of stones, chiseled cross (X) at corner point and B. 5–21000 A. Thence S. 55° E.
404.16	To Cor. No. 6. On line 1–2, Denver lode of this survey. A tubular iron post with flaring base, cement core and brass cap marked cross (X) at corner point and B. 6–21000 A. Thence S. 33° E.

Feet.	Survey No. 21000 A. — Continued.
	Boston Lode. — Continued.
317.76	Intersect North boundary Sec. 4 at West 826.46 ft. from N. E. Cor. said section.
440.83	Intersect line 3–4, Sur. No. 1685, Paris lode, at N. 40° E. 150.26 ft. from Cor. No. 3.
754.54	Intersect line 1–2, Sur No. 1685, Paris lode, at N. 40° E. 116.82 ft. from Cor. No. 2, also Intersect line 3–4, Golden lode, unsurveyed, at N. 40° E. 416.82 ft. from Cor. No. 3.
1068.25	Intersect line 1–2, Golden lode, unsurveyed, at N. 40° E. 325.11 ft. from Cor. No. 2.
1093.56	To Cor. No. 1, the place of beginning. Variation at all corners 14° 30′ E. Where no bearings to local witness objects are given at the several corners of this survey, none were available.
	Lode Lines
	As near as can be determined from present developments the vein of the Denver location extends 935 ft. N. 88° 25′ E. and 465 ft. S. 88° 25′ W. from face of discovery cut. The vein of the Boston location extends 1000 ft. S. 33° E. and 125 ft. N. 33° W., thence 375 ft. N. 55° W. from the discovery shaft.
	Survey No. 21000 B.
	London Mill Site
	Beginning at Cor. No. 1. A granite stone 24 × 14 × 7 ins. set 13 ins. in the ground with mound of stone chiseled cross (×) at corner point and L. M. S. 1–21000 B, whence The N. E. Cor. Sec. 4 T. 4 S. R. 73 W. 6th P. M. bears N. 71° 32′ E. 1331.22 ft. Thence S. 50° W.
250.0	Creek, 4 ft. wide, flows Southeast.
400.0	To Cor. No. 2. A pine post 4 ft. long, 4 ins. square, set 2 ft. in the ground with mound of stone, scribed cross (×) at corner point and L. M. S. 2–21000 B. Thence N. 40° W.
250.0	To Cor. No. 3. Identical with Cor. No. 3, Sur. No. 17556 B, Aztec *mill* site, claimant unknown.

Feet.	Survey No. 21000 B. — Continued.
	London Mill Site. — Continued.
	A rock in place showing 4 × 5 × 7 ft. above the general surface, chiseled 3–17556 B, cross (×) at corner point, and L. M. S. 3–21000 B.
	Thence N. 50° E.
160.0	Creek, 4 ft. wide, flows Southeast.
290.0	Cor. No. 2, Sur. No. 17556 B, Aztec mill site.
400.0	To Cor. No. 4.
	A granite stone 24 × 15 × 6 ins. set 14 ins. in the ground, with mound of stone, chiseled cross (×) at corner point and L. M. S. 4–21000 B, whence
	Cor. No. 3, Sur. No. 21000 A, Boston lode, bears N. 35° 40′ E. 350 ft.
	Thence S. 40° E.
250	To Cor. No. 1, the place of beginning.
	Variation at all corners 14° 30′ E.
	No bearing objects available at the several corners of this survey.

Area.		Acres.
Total area Denver lode		9.642
Area in conflict with—		
Sur. No. 1685, Paris lode	1.032	
Total area Boston lode		10.330
Area in conflict with—		
Sur. No. 1685, Paris lode	0.919	
Golden lode, unsurveyed	2.160	
Denver lode of this survey	1.392	
Total area London mill site		2.296

The surveys of the Boston lode and the London mill site are identical with their respective locations as staked upon the ground.

Location

This claim is located in the Unsubdivided T. 3 S., R. 73 W., and the N. E. ¼ of Sec. 4, T. 4 S., R. 73 W., 6th P. M.

Expenditure of Five Hundred Dollars

I certify that the value of the labor and improvements made upon, or for the benefit of, each of the lode locations embraced in said mining claim by the claimant or his grantors, is not less than five hundred dollars, and that said improvements consist of:

The discovery cut of the Denver lode, the face of which, being the discovery point, is on the center line 465 ft. from the center of line 2–3, 5 ft. wide, 10 ft. face, running S. 88° 25′ W. 20 ft. to mouth. Value, $200.

No. 1. The discovery shaft of the Boston lode which is on the center line, 1000 ft. from the center of line 1–2, 4 × 6 ft., 25 ft. deep. Value $250.

No. 2. A pit on the center line 775 ft. from the center of line 1–2, 4 × 4 ft., 10 ft. deep. Value, $50.

No. 3. A trench, the east end of which bears from Cor. No. 6, S. 22° 20′ E. 425 ft., 4 ft. wide, 8 ft. deep, running S. 57° W. 130 ft. Value, $600.

A common improvement, being a cross cut tunnel 5 × 6 ft., the mouth of which, situated on the London mill site, bears N. 77° 08′ W. 950 ft. from Cor. No. 2 Boston lode. Tunnel runs thence N. 43° E. 350 ft. to breast. Value, $3,500.

This improvement is in course of construction for the development of the Denver and Boston lodes, being all the contiguous lode locations owned in common within the range of benefit, and as described has been wholly constructed subsequent to the time since contiguity and common ownership have prevailed as between said lodes. The surface embraced in this claim ascends rapidly from the mouth of the tunnel towards Cor. No. 4, Denver lode. Therefore, the tunnel, continued with laterals run therefrom, will cut the veins of said locations at great depth, and thus afford a most advantageous and economical means of development.

An undivided one-half interest in the value of the improvement is therefore hereby credited as patent expenditure to each lode. No portion thereof or interest therein has heretofore been credited as patent expenditure.

Other Improvements

A shaft on the Boston lode, 4 × 6 ft., 30 ft. deep, which bears from Cor. No. 2, N. 23° 45′ W. 510 ft. Claimant unknown.

A cabin on the Denver lode, the N. W. Cor. of which bears from Witness Corner to Cor. No. 3, S. 83° 25′ E. 445 ft., 25 × 15 ft., course of long sides East. Claimant unknown.

A compressor house on the London mill site, the S. E. Cor. of which bears from Cor. No. 1, S. 72° 25′ W. 205 ft., 20 × 15 ft., course of long sides S. 75° E. Claimant herein.

Instrument

These surveys were made with a Buff and Berger transit, No. 2345. The courses were deflected from the true meridian as determined by direct solar observation.

The distances were measured with steel tapes.

Report

The boundary lines and connections of these surveys, as well as the lode lines of the two lode locations, were run directly upon the ground.

The N. E. Cor. Sec. 4, T. 4 S., R 73 W. 6th P. M. is a stone properly marked.

The N. ¼ Cor. said section is missing.

The N. W. Cor. Sec. 4, T. 4 S., R. 73 W. 6th P. M. is a stone properly marked.

The N. W. Cor. Sec. 4, T. 4 S., R. 73 W. 6th P. M. bears West 5,280 ft. from the N. E. Cor. said section.

Sur. No. 1685 Paris lode:

Cors. Nos. 1 and 2 are stones properly set and marked.

Cor. No. 6 is a post, standing, properly set and scribed.

Cors. Nos. 3, 4 and 5 are missing.

Lines 1–2 and 6–1 were found correct as approved.

Lines 2–3, 3–4 and 4–5 are shown as approved.

From Cor. No. 1, the N. E. Cor. Sec. 4, T. 4 S, R. 73 W. 6th P. M. bears S. 43° 34′ E. 216.71 ft. instead of S. 42° E. 218.0 ft. as approved.

Sur. No. 17556 B, Aztec mill site:

Cor. No. 3, identical with Cor. No. 3 London mill site of this claim, and Cor. No. 2 are rocks in place properly marked.

Line 2–3 was found to be S. 50° W. 290 ft. instead of S. 47° W. 300 ft. as approved.

Final Oaths for Surveys

List of Names

A list of the names of the individuals employed by **Frank Jones,** United States Mineral Surveyor, to assist in running, measuring, and marking the lines, corners, and boundaries described in the foregoing field notes of the survey of the mining claim of **Timothy Brown,** known as the **Denver** and **Boston Lodes** and the **London Mill Site** and showing the respective capacities in which they acted.

Keith Perry, Chainman.

Final Oaths of Assistants

I, **Keith Perry,** do solemnly swear that I assisted **Frank Jones,** United States Mineral Surveyor, in marking the corners and surveying the boundaries of the mining claim of **Timothy Brown,** known as the **Denver** and **Boston Lodes** and the **London Mill Site** represented in the foregoing field notes as having been surveyed by said mineral surveyor and under his

direction; and that said survey has been in all respects, to the best of my knowledge and belief, faithfully and correctly executed, and the corner and boundary monuments established according to law and the instructions furnished by the United States Surveyor General for **Colorado.**

Keith Perry, Chainman.

Subcribed and sworn to by the above-named persons before me this **first** day of **November, 1919.**

My commission expires Jan. 15, 1923.

JOHN A. WILSON.
Notary Public in and for **Clear Creek** County, Colorado.

Final Oath of U. S. Mineral Surveyor

I, **Frank Jones,** U. S. Mineral Surveyor, do solemnly swear that, in pursuance of instructions received from the United States Surveyor General for **Colorado,** dated **September 1, 1919,** I have, in strict conformity to the laws of the United States, the official regulations and instructions thereunder, and the instructions of said Surveyor General, faithfully and correctly executed the survey of the Mining Claim of **Timothy Brown,** known as the **Denver** and **Boston Lodes** and the **London Mill Site,** situate in **Coral** Mining District, **Clear Creek** County, **Colorado,** in Unsubdivided **T. 3 S.** and in Section **4,** Township No. **4 S.** Range No. **73 W. 6th P. M.** and designated as **Survey No. 21000 A and B,** as represented in the foregoing field notes, which accurately show the boundaries of said mining claim as distinctly marked by monuments on the ground, and described in the attached copy of each location certificate, which was received by me from the Surveyor General with said instructions, and that all the corners of said survey have been established and perpetuated in strict accordance with the law, official regulations and instructions thereunder; and I do further solemnly swear that the foregoing are the true and original field notes of said survey and my report therein, and that the labor expended and improvements made upon or for the benefit of each of the lode locations embraced in said mining claim by claimant or his grantors are as therein fully stated, and that the character, extent, location, and itemized value thereof are specified therein with particularity and full detail, and that no portion of or interest in said labor or improvements so credited to this claim has been included in the estimate of expenditures upon any other claim.

FRANK JONES,
U. S. Mineral Surveyor.

Subscribed and sworn to by the said **Frank Jones,** U. S. Mineral Sur-

veyor, before me, **John A. Wilson, a Notary Public in and for Clear Creek County, Colorado, this first day of November, 1919.**

My commission expires Jan. 15, 1923.

JOHN A. WILSON.

[Seal.]

Location Certificate, Lode Claim

STATE OF COLORADO, } ss.
County of **Clear Creek** }

KNOW ALL MEN BY THESE PRESENTS: That **Timothy Brown** the undersigned has this **20th** day of **March, 1918,** located and claimed, and by these presents does locate and claim by right of discovery and location, in compliance with the Mining Acts of Congress, approved May 10, 1872, and all subsequent acts, and with local customs, laws and regulations, **1,500** linear feet and horizontal measurement on the **Denver** lode, vein, ledge or deposit, along the vein thereof, with all its dips, angles and variations as allowed by law, together with **150** feet on each side of the middle of said vein at the surface, so far as can be determined from present developments; and all veins, lodes, ledges or deposits and surface ground within the lines of said claim, **1,035** feet running **N. 88° 25′ E.** from face of discovery **cut** and **465** feet running **S. 88° 25′ W.** from **face** of discovery **cut,** said discovery **cut** being situate upon said lode, vein, ledge or deposit, and within the lines of said claim, in **Coral** Mining District, County of **Clear Creek** and State of Colorado, described by metes and bounds as follows, to wit:

Beginning at Corner No. 1, **Thence S. 88° 25′ W. 1500 ft. to Cor. No. 2.**

Thence N. 1° 35′ W. 300 ft. to Cor. No. 3.

Thence N. 88° 25′ E. 1,500 ft. to Cor. No. 4.

Thence S. 1° 35′ E. 300 ft. to Cor. No. 1, the place of beginning.

From **Cor. No. 1** the **N. E. Cor. Sec. 4 T. 4 S. R. 73 W. 6th P. M. bears South 290 ft.**

TIMOTHY BROWN. [Seal.]

Date of Location, **March 20,** A.D. **1918.**
Date of Certificate, **March 20,** A.D. **1918.**

Location Certificate, Lode Claim

STATE OF COLORADO, } ss.
County of **Clear Creek** }

KNOW ALL MEN BY THESE PRESENTS: That Timothy Brown

the undersigned has this 9th day of April, 1918, located and claimed, and by these presents does locate and claim by right of discovery and location, in compliance with the Mining Acts of Congress, approved May 10, 1872, and all subsequent acts, and with local customs, laws and regulations, 1,500 linear feet and horizontal measurement on the Boston lode, vein, ledge or deposit, along the vein thereof, with all its dips, angles and variations as allowed by law, together with 150 feet on each side of the middle of said vein at the surface, so far as can be determined from present developments; and all veins, lodes, ledges or deposits and surface ground within the lines of said claim, 1,000 feet running S. 33° E. from center of discovery shaft and 125 feet running N. 33° W. Thence 375 feet running N. 55° W. from center of discovery shaft, said discovery shaft being situate upon said lode, vein, ledge or deposit, and within the lines of said claim, in Coral Mining District, County of Clear Creek and State of Colorado, described by metes and bounds as follows, to wit:

Beginning at Corner No. 1, Thence S. 35° W. 323.56 ft. to Cor. No. 2.

Thence N. 33° W. 1,156.44 ft. to Cor. No. 3.

Thence N. 55° W. 345.84 ft. to Cor. No. 4.

Thence N. 35° E. 300 ft. to Cor. No. 5.

Thence S. 55° E. 404.16 ft. to Cor. No. 6.

Thence S. 33° E. 1,093.56 ft. to Cor. No. 1, the place of beginning Cor. No. 4 is identical with Cor. No. 2 Denver lode.

TIMOTHY BROWN. [Seal.]

Date of Location, April 9, A.D. 1918.
Date of Certificate, April 9, A.D. 1918.

Location Certificate of Mill Site

STATE OF COLORADO, } ss.
County of Clear Creek }

TO ALL WHOM THESE PRESENTS MAY CONCERN:

Know ye that I, James Franklin, of Denver, Colorado, do hereby declare and publish as a legal notice to all the world that I have a valid right to the occupation, possession and enjoyment of all and singular that tract or parcel of land not exceeding five acres, situate, lying and being in Coral Mining District, in the County of Clear Creek in the State of Colorado, bounded and described as follows, to wit: The London Mill Site, beginning at Cor. No. 1.

Thence S. 50° W. 400 ft. to Cor. No. 2.

Thence N. 40° W. 250 ft. to Cor. No. 3.

Thence N. 50° E. 400 ft. to Cor. No. 4.

Thence S. 40° E. 250 ft. to Cor. No. 1, the place of beginning.

Cor. No. 3 is identical with Cor. No. 3, Sur. No. 17556 B, Aztec Mill Site together with all and singular the hereditaments and appurtenances thereunto belonging or in anywise appertaining.

Witness my hand and seal this 6th day of January in the year of our Lord one thousand nine hundred and ten.

JAMES FRANKLIN. [Seal.]

(4—687)

Surveyor General's Certificate of Approval of Field Notes and Survey of Mining Claim

DEPARTMENT OF THE INTERIOR,
Office of U. S. Surveyor General,

.....

.....19...

I, U. S. Surveyor General for ....., do hereby certify that the foregoing and hereto attached field notes and return of the survey of the mining claim of ....., known as the ....., situate in ..... mining district, ... County, ..., in Section ....., Township No. ....., Range No. ....., designated as Survey No. ....., executed by ....., U. S. mineral surveyor, ... 19.... , under my instructions dated ..... 19..., have been critically examined and the necessary corrections and explanations made, and the said field notes and return, and the survey they describe, are hereby approved. A true copy of the location certificate filed by the applicant for survey is included in the field notes.

.....

U. S. Surveyor General for .....

(4—688)

United States Surveyor General's Final Certificate on Field Notes

DEPARTMENT OF THE INTERIOR,
Office of U. S. Surveyor General,

.....

..... 19...

I, U. S. Surveyor General for ....., do hereby certify that the foregoing transcript of the field notes, return, and approval of the survey of the mining claim of ....., known as the ....., situate in ..... mining district, ... County, ..., in Section ....., Township, No. ....., Range No. .... , and desig-

[illegible] as [illegible] has been [illegible] [illegible] [illegible]

Placer Location Certificate by Legal Subdivisions

KNOW ALL MEN BY THESE PRESENTS, That I, **T. E. Jenkins,** the undersigned citizen of the United States, resident of the County of **Arapahoe,** State of Colorado, having complied with the provisions of Chapter 6, Title XXXII of the Revised Statutes of the United States, and with the local customs, laws and regulations, claim by right of discovery and location, as a placer claim, the following described premises, situate, lying and being in **Pike's Peak** Mining District, County of **El Paso** and State of Colorado, to wit: **The S. E. ¼ of the S. W. ¼, and the S. ½ of the S. W. ¼ of the S. W. ¼ of Sec. 17, T. 14 S., R. 69 W. of the 6th P. M.** To be known as the **Cumro Placer.** Said claim was located on the **1st** day of **May,** A.D. 1892; date of Certificate, **June 4th,** A.D. 1892.

T. E. JENKINS.

As no placer notes are given in the 1909 "Manual of Instructions," the following is taken from the Manual of 1895:

(Title Page to Report Under Circular "N" of September 23, 1882.)

Report

Under General Land Office Circular "N" of September 23, 1882, upon the Placer Mining Claim known as the **Cumro placer,** claimed by **T. E. Jenkins et al.,** situate in **Pike's Peak** Mining District, **El Paso** County, **Colorado,** embracing **32.07 acres, and forming a portion of the S. half of the S. W. quarter** in Sec. **17,** Town. **14 S.,** Range **69 W. of the 6th P. M.**

Examination made **February 15th, 1909.**

By **A. L. HAWLEY,**
U. S. Mineral Surveyor.

Survey No. 20001

Cumro Placer

a The soil embraced in this claim consists of decomposed mineral-bearing granite on the mountain slopes, and auriferous sand and gravel along the creek bottom, all covered with a thin layer of loam and alluvium supporting a scant growth of grass and sage brush, with scattering pine, spruce, cedar and cotton-wood timber.

b The only stream passing through this claim is Cumro creek, 4 ft. wide, and about 2 ft. deep, which crosses the extreme southeast corner.

A log cabin, the west corner of which bears from Cor. No. 13 S. 40° E. 120 ft., 12 × 16 ft., course of long sides N. 44° E.

c | The surface and underground workings on this claim consist of:

A tunnel, the mouth of which bears from Cor. No. 7 N. 67° 48′ E. 582 ft., 5 × 6 ft., running N. 10° 44′ W. 515 ft. to breast.

A shaft, which bears from Cor. No. 28 S. 48° 30′ W. 305 ft., 3 × 5 ft., 12 ft. deep in earth and rock. Placer workings, the center of the northeasterly end of which bears from Cor. No. 15 N. 46° W. 285 ft., averaging 40 ft. wide and 8 ft. deep, and extending S. 62° W. 120 ft. along the bed of Cumro creek.

d | The nearest postoffice to the claim is Jamestown, a mining camp of about 300 population, located on Brush creek about two miles south of the claim. The nearest railroad station is Tie Siding, a spur and flag station on the Denver, Apex and Western R. R., at the confluence of Cumro and Plum creeks, about 6 miles southwesterly from the claim.

e | Other than the system of lode deposits adjoining and forming a part of this claim, there are none nearer than Carbonate, situated about four miles to the northeast.

f | This claim is peculiarly adapted for placer mining purposes, inasmuch as the contour of the surface and the character and nature of the soil are such that it can be most advantageously and cheaply worked by hydraulic giants and the tailings be rapidly and easily disposed of. Cumro creek carries about 50 cu. ft. of water per second during the dry season, being an abundance of water for working the claim. As yet no water has been taken upon the claim for its development, except in washing the placer workings hereinbefore described; but by a survey it has been found that by a ditch not over one mile in length, water can be taken from Cumro creek onto the highest portions of the claim. It being the express intention of the claimants to work the claim in this manner.

g | The works and expenditures made by the claimants for the development of the claim consist of the placer workings described under paragraph *c* of this report.

h | There are no mines, salt licks, salt springs, or mill seats upon this claim.

Oath of U. S. Mineral Surveyor

Under General Land Office Circular "N" of September 23, 1882

I, **A. L. Hawley,** U. S. Mineral Surveyor, do solemnly swear that in pursuance of an order received from the U. S. Surveyor General for Colo-

rado, dated February 6th, 1909, I have made, under the provisions of General Land Office Circular "N," approved September 23, 1882, a personal and thorough examination, upon the premises, of the placer mining claim of T. E. Jenkins et al., known as the Cumro placer, situate in Pike's Peak Mining District, El Paso County, Colorado, embracing 32.07 acres and forming a portion of the S. ½ of the S. W. ¼ of Sec. 17 in Township No. 14 S., Range No. 69 W. of the 6th P. M., and that my report of such examination, hereto attached, is specific and in detail, and is a full and true statement of the facts upon all the points specified in said Circular.

A. L. HAWLEY,
U. S. Mineral Surveyor.

Subscribed and sworn to by the said A. L. Hawley, U. S. Mineral Surveyor, before me, a notary public in and for El Paso County, Colorado, this 20th day of February, 1909.

B. F. CLARK,
Notary Public.

My commission expires December 20, 1910.

Corroborative Affidavit under Paragraph 62, General Mining Circular, Approved June 24, 1899

STATE OF COLORADO, }
County of El Paso } ss.

W. H. Wilson and J. P. Thompson, being first duly sworn, severally depose and say that he is personally and well acquainted with the placer-mining claim of T. E. Jenkins et al., known as the Cumro placer, situate in Pike's Peak Mining District, El Paso County, Colorado, embracing 32.07 acres and forming a portion of the S. ½ of the S. W. ¼ of Sec. 17, in Township No. 14 S., Range No. 69 W. of the 6th P. M.; and also with the character of all the land included in said claim, and has been so acquainted for 10 and 12 years last past; that his knowledge of said claim and land is derived from prospecting the ground and working the claim and is such as to enable him to testify understandingly with regard thereto; that he has carefully read the foregoing report of A. L. Hawley, U. S. Mineral Surveyor, and that to his own personal knowledge said report is in all respects true and accurate.

W. H. WILSON.
J. P. THOMPSON.

Subscribed and sworn to by the above-named persons before me this 20th day of February, 1909.

(Seal.)

B. F. CLARK,
Notary Public.

My commission expires December 20, 1910.

CHAPTER VII

LAND OFFICE AND RECORDS

Office of United States Surveyor General

The province of the office of surveyor general for any district is to supervise the surveys of the public land in that district.

The agricultural land is subdivided into townships 6 miles square, each township again into 36 sections, each 1 mile square, containing 640 acres, which can be still further subdivided to suit the convenience of persons desiring to obtain title thereto. This surveying work is done by contract made between the surveyor appointed a deputy surveyor, and the Government, the price paid the deputy being from $5 to $7 per mile for subdivision, $7 to $11 per mile for township exteriors, and from $9 to $13 per mile for connection and meander lines. After these surveys are once made and approved by the surveyor general and the General Land Office, the surveyor general has no more authority in the matter, unless, on account of fraudulent surveys or some similar cause, the surveys in question are suspended, and new and correct surveys are made.

In surveying mineral claims, an entirely different method is followed. The surveying is done by United States mineral surveyors employed by the owner of the claim to be patented. These mineral surveyors are appointed by the surveyor general, who, if he sees fit, may require the applicant to pass an examination. Section 2334 of the re-

vised statute, making provision for these appointments, being in part as follows:

Sec. 2334. The Surveyor General of the United States may appoint in each land district containing mineral lands as many competent surveyors as shall apply for appointment to survey mining claims. The expenses of the survey of vein or lode claims, and the survey and subdivision of placer claims into smaller quantities than one hundred and sixty acres, together with the cost of publication of notices, shall be paid by the applicants, and they shall be at liberty to obtain the same at the most reasonable rates, and they shall also be at liberty to employ any U. S. mineral surveyor to make the survey. The Commissioner of the General Land Office shall also have power to establish the maximum charges for surveys and publication of notices under this chapter; and, in case of excessive charges for publication, he may designate any newspaper published in a land district where mines are situated for the publication of mining notices in such district, and fix the rates to be charged by such paper; and, to the end that the Commissioner may be fully informed on the subject, each applicant shall file with the register a sworn statement of all charges and fees paid by such applicant for publication and surveys, together with all fees and money paid the register and the receiver of the land office, which statement shall be transmitted, with the other papers in the case, to the Commissioner of the General Land Office.

Before appointment of a mineral surveyor is made he is required to file a bond of $5,000 for the faithful performance of his duties.

Upon receipt by the surveyor general of the application for survey order, together with the certified copy of location certificate and duplicate certificate of deposit for the

necessary amount on account of office work, the application and copy of location certificates are examined on the following points:

Application for survey order must give —

Name of claimant;

Name of claim;

Name and address of mineral surveyor to whom order is to be sent;

Postoffice address of claimant;

Signature of the claimant or his attorney; typewritten signatures will not be accepted.

The examination of the copy of the location certificate consists of a traverse of the boundary lines of the claim, which must close.

Claim must be tied to some permanent or fixed monument, or so described that the locus of the claim can be determined (by giving section, or mining district in which claim is located).

The certificate must give —

Name of claim;

Name of locators;

Date of location;

Date and place (book and page) of record;

Certificate of county clerk, with his signature, seal and date, regarding correctness of document.

All dates must be consistent.

In case of a lode claim, the lode line must be described and must fit within the boundaries of the claim, and not be in excess of the statutory limit from any side line, nor over 1,500 feet in length.

In case of placer claims, the acreage must be calculated, and not over 20 acres allowed for each individual locator.

In case of mill sites, not more than 5 acres may be included in the exterior boundaries.

If these papers are correct, the order for survey is mailed to the mineral surveyor designated, who should then proceed to make the survey and return the field notes, prepared on the proper blanks, to the surveyor general, together with a plat of the claim prepared on tracing linen on a scale of 200 feet to an inch.

The three blanks, title page, affidavit of the mineral surveyor and affidavit of assistants, are examined to see that they agree clerically with each other and with the application for survey order regarding names, dates, etc. This is done by the chief examiner, who also examines the field notes for clerical errors, notes that all intersections with lines of conflicting surveys are properly given, that the area statement is complete, and that the improvements are properly described and actually benefit the claims to which they are credited.

The field notes are then taken up for examination on the connected sheets, which are diagrams showing all approved mineral surveys. The sheet examination consists of platting the claim on this diagram, ascertaining that all conflicting approved surveys are shown in the field notes and that all such claims are shown in their correct positions. After the sheet examination, the intersections, conflicting areas, lode line, etc., are checked. Should errors be discovered in the field notes at any stage, the notes are returned to the mineral surveyor for correction. This may be done many times, till the final draft is found to be correct. When all is found to be correct, the plat, as approved, and transcript of notes are prepared, and upon date of approval two copies of the plat and a transcript of the field notes are mailed to the claimant, or attorney, one

copy of the plat mailed to the local land office, and one copy of the plat and the original field notes retained in office of the surveyor general. The mineral surveyor is notified at date of approval of field notes.

The following numbered paragraphs are from the Regulations of the General Land Office.

36. The surveyors general should designate all surveyed mineral claims by a progressive series of numbers, beginning with Survey No. 37, irrespective as to whether they are situated on surveyed or unsurveyed lands, the claim to be so designated at date of issuing the order therefor, in addition to the local designation of the claim; it being required in all cases that the plat and field notes of the survey of a claim must, in addition to the reference to permanent objects in the neighborhood, describe the locus of the claim with reference to the lines of public surveys by a line connecting a corner of the claim with the nearest public corner of the United States surveys, unless such claim be on unsurveyed lands at a distance of more than two miles from such public corner, in which latter case it should be connected with a United States mineral monument. Such connecting line must not be more than two miles in length, and should be measured on the ground direct between the points, or calculated from actually surveyed traverse lines, if the nature of the country should not permit direct measurement. If a regularly established survey corner is within two miles of a claim situated on unsurveyed lands, the connection should be made with such corner in preference to a connection with a United States mineral monument. The connecting line or traverse line must be surveyed by the mineral surveyor at the time of his making the particular survey, and be made a part thereof.

Placer Claims

58. The proceedings to obtain patents for placer claims, including all forms of mineral deposits, excepting veins of quartz or other rock in place, are similar to the proceedings prescribed for obtaining patents for vein or lode claims; but where a placer claim shall be upon surveyed lands, and conforms to legal subdivisions, no further survey or plat will be required. Where placer claims cannot be conformed to legal subdivisions, survey and plat shall be made as on unsurveyed lands.

59. The proceedings for obtaining patents for veins or lodes having already been fully given, it will not be necessary to repeat them here, it being thought that careful attention thereto by applicants and the local officers will enable them to act understandingly in the matter, and make such slight modifications in the notice, or otherwise, as may be necessary in view of the different nature of the two classes of claims. Placer claims being fixed, however, at two dollars and fifty cents per acre, or fractional part of an acre.

60. In placer applications, in addition to the recitals necessary in and to both vein or lode and placer applications, the placer application should contain, in detail, such data as will support the claim that the land applied for is placer ground containing valuable mineral deposits not in vein or lode formation, and that title is sought not to control water courses or to obtain valuable timber, but in good faith because of the mineral therein. This statement, of course, must depend upon the character of the deposit and the natural features of the ground, but the following details should be covered as fully as possible: If the claim be for a deposit of placer gold, there must be stated the yield per *pan, or* cubic yard, as shown by prospecting and

development work, distance to bedrock, formation and extent of the deposit, and all other facts upon which he bases his allegation that the claim is valuable for its deposits of placer gold. If it be a building stone or other deposit than gold claimed under the placer laws, he must describe fully the kind, nature, and extent of the deposit, stating the reasons why same is by him regarded as a valuable mineral claim. He will also be required to describe fully the natural features of the claim; streams, if any, must be fully described as to their course, amount of water carried, fall within the claim; and he must state kind and amount of timber and other vegetation thereon and adaptability to mining or other uses.

If the claim be all placer ground, that fact must be stated in the application and corroborated by accompanying proofs; if of mixed placers and lodes, it should be so set out, with a description of all known lodes situated within the boundaries of the claim. A specific declaration, such as is required by section 2333, Revised Statutes, must be furnished as to each lode intended to be claimed. All other known lodes are, by the silence of the applicant, excluded by law from all claim by him, of whatsoever nature, possessory or otherwise.

While this data is required as a part of the mineral surveyor's report under paragraph 167, in case of placers taken by special survey, it is proper that the application for patent incorporate these facts under the oath of the claimant.

Inasmuch as in case of claims taken by legal subdivisions, no report by a mineral surveyor is required, the claimant, in his application, in addition to the data above required, should describe in detail the shafts, cuts, tunnels, or other workings claimed as improvements, giving their dimensions, value, and the course and distance thereof to the nearest corner of the public surveys.

As prescribed by paragraph 25, this statement as to the description and value of the improvements must be corroborated by the affidavits of two disinterested witnesses.

Applications awaiting entry, whether published or not, must be made to conform to these regulations, with respect to proof as to the character of the land. Entries already made will be suspended for such additional proofs as may be deemed necessary in each case.

Local land officers are instructed, that if the proofs submitted in placer applications under this paragraph are not satisfactory as showing the land as a whole to be placer in character, or if the claims impinge upon or embrace water courses or bodies of water, and thus raise a doubt as to the bona fides of the location and application, or the character and extent of the deposit claimed thereunder, to call for further evidence, or, if deemed necessary, request the specific attention of the Chief of Field Service thereto, in connection with the usual notification to him under the circular instructions of April 24, 1907, and to suspend further action on the application until a report thereon is received from the field officer.

Mill Sites

61. Land entered as a mill site must be shown to be non-mineral. Mill sites are simply auxiliary to the working of mineral claims, and as section 2337, which provides for the patenting of mill sites, is embraced in the chapter of the Revised Statutes relating to mineral lands, they are therefore included in this circular.

62. To avail themselves of this provision of law, parties holding the possessory right to a vein or lode claim, and to a piece of non-mineral land not contiguous thereto, for mining or milling purposes not exceeding the quantity

allowed for such purpose by section 2337, or prior laws, under which the land was appropriated, the proprietors of such vein or lode may file in the proper land office their application for a patent, under oath, in manner already set forth herein, which application, together with the plat and field notes, may include, embrace, and describe, in addition to the vein or lode, such non-contiguous mill site, and after due proceedings as to notice, etc., a patent will be issued conveying the same as one claim. The owner of a patented lode may, by an independent application, secure a mill site if good faith is manifest in its use or occupation in connection with the lode, and no adverse claim exists.

63. Where the original survey includes a lode claim and also a mill site, the lode claim should be described in the plat and field notes as "Sur. No. 37, A," and the mill site as "Sur. No. 37, B," or whatever may be its appropriate numerical designation; the course and distance from a corner of the mill site to a corner of the lode claim to be invariably given in such plat and field notes, and a copy of the plat and notice of application for patent must be conspicuously posted upon the mill site as well as upon the vein or lode for the statutory period of sixty days. In making the entry no separate receipt or certificate need be issued for the mill site, but the whole area of both lode and mill site will be embraced in one entry, the price being five dollars for each acre and fractional part of an acre embraced by such lode and mill-site claim.

64. In case the owner of a quartz mill or reduction works is not the owner or claimant of a vein or lode, the law permits him to make application therefor in the same manner prescribed herein for mining claims, and, after due notice and proceedings, in the absence of a valid adverse filing, to enter *and receive* a patent for his mill site at said price per acre.

65. In every case there must be satisfactory proof that the land claimed as a mill site is not mineral in character, which proof may, where the matter is unquestioned, consist of the sworn statement of two or more persons capable, from acquaintance with the land, to testify understandingly.

Adverse Claims

82. In order that the "boundaries" and "extent" of the claim may be shown, it will be incumbent upon the adverse claimant to file a plat showing his entire claim, its relative situation or position with the one against which he claims, and the extent of the conflict: Provided, however, That if the application for patent describes the claim by legal subdivisions, the adverse claimant, if also claiming by legal subdivisions, may describe his adverse claim in the same manner without further survey or plat. If the claim is not described by legal subdivisions, it will generally be more satisfactory if the plat thereof is made from an actual survey by a mineral surveyor, and its correctness officially certified by him.

Appointment by Surveyor General and Charges

91. With regard to the platting of the claim and other office work in the surveyor general's office, that officer will make an estimate of the cost thereof, which amount the claimant will deposit with any assistant United States treasurer or designated depository in favor of the United States Treasurer, to be passed to the credit of the fund created by "individual depositors for surveys of the public lands," and file with the surveyor general duplicate certificates of such deposit in the usual manner.

92. The surveyors general will endeavor to appoint sur-

veyors to survey mining claims, so that one or more may be located in each mining district for the greater convenience of miners.

93. The usual oaths will be required of these surveyors and their assistants as to the correctness of each survey executed by them.

The duty of the surveyor ceases when he has executed the survey and returned the field notes and preliminary plat thereof with his report to the surveyor general. He will not be allowed to prepare for the mining claimant the papers in support of an application for patent, or otherwise preform the duties of an attorney before the Land Office in connection with a mining claim.

The surveyors general and local land officers are expected to report any infringement of this regulation to this office.

94. Should it appear that excessive or exorbitant charges have been made by any surveyor or any publisher, prompt action will be taken with the view of correcting the abuse.

Surveys of Mining Claims

General Provisions

115. Under section 2334, United States Revised Statutes, the United States surveyor general "may appoint in each land district containing mineral lands as many competent surveyors as shall apply for appointment to survey mining claims."

116. Persons desiring such appointments should therefore file their applications with the surveyor general for the district wherein appointment is asked, who will furnish all information necessary.

117. All appointments of mineral surveyors must be sub-

mitted to the Commissioner of the General Land Office for approval.

118. The surveyors general have authority to suspend or revoke the commissions of mineral surveyors for cause. Before final action, however, the matter should be submitted to the Commissioner of the General Land Office for approval.

119. Such surveyors will be allowed the right of appeal from the action of the surveyor general in the usual manner. Such appeal should be filed with the surveyor general, who will at once transmit the same, with full report, to the General Land Office.

120. Neither the surveyor general nor the Commissioner of the General Land Office has jurisdiction to settle differences, relative to the payment of charges for field work, between mineral surveyors and claimants. These are matters of private contract and must be enforced in the ordinary manner, i.e., in the local courts. The Department has, however, authority to investigate charges affecting the official actions of mineral surveyors, and will, on sufficient cause shown, suspend or revoke their appointment.

121. The surveyors general should appoint as many competent mineral surveyors as apply for appointment, in order that claimants may have a choice of surveyors, and be enabled to have their work done on the most advantageous terms.

122. The schedule of charges for office work should be as low as is possible. No additional charges should be made for orders for amended surveys, unless the necessity therefor is clearly the fault of the claimant, or considerable additional office work results therefrom.

123. In cases where the error in the original survey is due to the carelessness or neglect of the surveyor who

made it, he should be required to make the necessary corrections in the field at his own expense, and the surveyor general should advise him that the penalty for failure to comply with instructions within a specified time will be the suspension or revocation of his commission.

124. Mineral surveyors will address all official communications to the surveyor general. They will, when a mining claim is the subject of correspondence, give the name and survey number. In replying to letters they will give the subject matter and date of the letter. They will promptly notify the surveyor general of any change in postoffice address.

125. Mineral surveyors should keep a complete record of each survey made by them and the facts coming to their knowledge at the time, as well as copies of all their field notes, reports, and official correspondence, in order that such evidence may be readily produced when called for at any future time. Field notes and other reports must be written in a clear and legible hand, or typewritten in noncopying ink, and upon the proper blanks furnished gratuitously by the surveyor general's office upon application therefor. No interlineations or erasures will be allowed.

126. No return by a mineral surveyor will be recognized as official, unless it is over his signature as a United States mineral surveyor, and made in pursuance of a special order from the surveyor general's office. After he has received an order for survey he is required to make the survey and return correct field notes thereof to the surveyor general's office without delay.

127. The claimant is required, in all cases, to make satisfactory arrangements with the surveyor for the payment for his services and those of his assistants in making

the survey, as the United States will not be held responsible for the same.

128. A mineral surveyor is precluded from acting, either directly or indirectly, as attorney in mineral claims. His duty in any particular case ceases when he has executed the survey and returned the field notes and preliminary plat, with his report, to the surveyor general. He will not be allowed to prepare for the mining claimant the papers in support of his application for patent, or otherwise perform the duties of an attorney before the Land Office in connection with a mining claim. He is not permitted to combine the duties of surveyor and notary public in the same case by administering oaths to the parties in interest.

It is preferable that both preliminary and final oaths of assistants should be taken before some officer duly authorized to administer oaths, other than the mineral surveyor. However, in cases where great delay, expense, or inconvenience would result from a strict compliance with this rule, the mineral surveyor is authorized to administer the necessary oaths to his assistants, but in each case where this is done, he will submit to the proper surveyor general a full written report of the circumstances which required his stated action; otherwise he must have absolutely nothing to do with the case, except in his official capacity as surveyor. He will not employ chainmen interested therein in any manner.

In the Appendix will be found a copy of the "Manual of Instructions for the Survey of the Mineral Lands of the United States," 1909.

The Surveyor General of Colorado has issued the following circular letter and requires mineral surveyors to comply strictly *therewith:*

In your future work before this office you will comply in detail with the requirements contained in amended paragraph 147 of Mining Circular, and to insure uniformity in your returns will pay particular attention to the following instructions:

As said amendment requires that all conflicting surveys shall be shown according to the boundaries as each is marked, defined and accurately established upon the ground without regard to whether or not patents have been issued for the claims in question, you will be required to determine in each case that the monuments of conflicting claims as found upon the ground are the official monuments of the official surveys, or occupy the original position of the same. If this cannot be determined it will be necessary to revert to the record and show said claims in their approved and patented positions.

A strict compliance with paragraph 149 of the Mining Circular, which is in part as follows, will be required:

"If in running the exterior lines of a claim the survey is found to conflict with the survey of another claim, the distances to the points of intersection and the courses and distances along the line intersected from an established corner of such conflicting claim to such points of intersection, should be described in the field notes.". . .

This will necessitate the re-running by you of each line of a conflicting survey which intersects the exterior lines of the claim being surveyed, and a report upon the course, and, if necessary, the length of the same.

The section and quarter section in which a survey is located will be determined, assuming the subdivision field notes as returned by the mineral surveyor to be correct.

You will further be required in the field notes, when connections are given to a conflicting or neighboring sur-

vey, to state whether or not said connection is given to the position of the claim as staked or as approved by this office.

An additional note added at the end of the field notes, under heading "Report," will be required, stating:

1st. How the lines of the survey, connections to conflicting surveys and to the corner of the public survey or U. S. Location Monument, were determined.

2nd. A description of the section corner or U. S. Location Monument to which connection is given in the field notes.

3rd. A full description of all corners of conflicting claims to which connections are given in the field notes, together with a statement of how and by what visible evidence you are able to identify the same as being the official monuments of the claim in question.

4th. A statement showing how the courses and lengths of the intersecting boundary lines of conflicting surveys were determined.

The following circular letter is also of interest:

DEPARTMENT OF THE INTERIOR,
Office of
United States Surveyor General, for the District of Colorado.

Denver, Colo., May 25, 1892.

To Applicants for Mineral Survey Orders
in the District of Colorado:

You are informed that in numerous cases the certified copies of location certificates filed in this office with applications for mineral survey orders are so defective that orders cannot be based thereon. This is a very important matter, and locators cannot exercise too much care in defining their locations at the outset, inasmuch as the act of Congress of May 10, 1872, provides "That all records of mining claims hereafter made shall contain the name or names of the locators, the date of location, and such a

description of the claim or claims located by reference to some natural object or permanent monument as will identify the claim."

It is also provided by the General Statutes of Colorado, section 2400, that "Any location certificate of a lode claim which shall not contain the name of the lode, the name of the locator, the date of location, the number of linear feet claimed on each side of the discovery shaft, the general course of the lode and such description as shall identify the claim with reasonable certainty, shall be void."

One or more of these requirements is often omitted in location certificates submitted to this office, and you are therefore advised, before filing your application, to see that your location has been made in conformity with law and regulations, and that the claim for which patent is sought is properly described.

A fruitful source of delay is the failure of applicants, their agents or attorneys, to thoroughly examine the copies of location certificates received from the county clerk, comparing the same with the **original,** to see that clerical errors have been avoided. The discovery of such errors in this office necessitates the return of the document for correction, causes delay in the issuance of the order for survey, and, by allowing the intervention of other orders with prior numbers, retards the approval of the survey often for many weeks. You are therefore requested, before filing a copy of a location certificate in this office, to examine the same carefully and see.

That the distances given each way from the discovery do not aggregate more than 1,500 feet, and equal the length of the claim along the vein, as determined from the description by metes and bounds thereof. That not more than the statutory limit is claimed on either side of the discovery, that the discovery is not described in one place as a shaft and in another as a cut or tunnel; that the end lines are parallel; that the courses and distances given as the boundaries of the claim **close;** that the dates are **correct and consistent;** that the name of the claim is legibly written; that the certificate of the county clerk is properly **sealed, dated, signed,** correctly gives the name of the claim and designates the instrument, as a location, amended, additional or relocation certificate, as the case may be. The importance of attending to these details in the matter of location will be the more readily perceived when it is understood that a failure to give the subject proper attention may invalidate the claim.

E. C. HUMPHREY,
United States Surveyor General for Colorado.

Records

As the mineral surveyor and others are constantly required to consult the records on file in the surveyor gen-

eral's office, it will be well to give an account of the methods used in the Colorado office:

All claims are indexed alphabetically and numerically. In the alphabetical index there is no information except the name of the claim, its number and land district. In the numerical index is given the number of the claim, the name or names, the claimant, surveyor, date of filing, plat book number, field book number, date of patent or cancellation, township and section, and, under remarks, any further information. The plat books, of which there are over two hundred at present, each contain about one hundred facsimilies of the plats of approved claims. These plats show at a glance the position of the claim and its conflicts, the net area being colored, ties, intersections, improvements, etc., and are probably the most consulted by those desiring information. For additional information the bound field notes filed by the mineral surveyor are used. In addition, all correspondence with the General Land Office, if any, is kept on file and may be consulted if required. The so-called connected sheets each embrace a square mile on which all claims in the area embraced are platted on a scale of 300 feet to the inch. Notes from any of these records may be made by anyone interested or entitled to information, or copies, certified or otherwise, will be made in the surveyor general's office for a nominal fee.

The mineral surveyor, as a rule, finds it necessary to keep a complete record of the claims in his district for the benefit of his clients, and is required by the General Land Office to keep a complete record of all official work done by himself. In this way every mineral surveyor's office is a more or less complete reproduction in miniature of the surveyor general's office, as far as his own district is con-

cerned. The writer's method of keeping records is as follows:

The card catalogue system is employed throughout where possible. Each claim is catalogued alphabetically on cards (with a number of names of claims on each card), and also catalogued numerically with one number to each card. This latter card contains data as follows:

Sur. No. **16721.** Name **Silver Star.**
Surveyor **John Smith.** Date **March 20, 1903.**
Notes **Scrap Book 101.** Plats **Vol. 12.**
Maps.
N. W. Sec. **31,** T. **3** S., R. **73** W. Patent **June 20, 1905.**
District **Montana.**
Claimant **Henry Jones.**
Area **5.045 acres.**
Remarks

These constitute the index cards.

The skeleton field notes, an example of which is given below, are also copied on a card which is catalogued numerically. (These should contain the metes and bounds of the claim, the section ties and ties to other claims; it is well to have a note of the corners, whether they be stones, posts, etc.):

16721	Silver Star.		
1	S. E. 25–3–74 N.	38° 51′ W.	1961.7.
1–2	S. 50° 30′ E.	150	1 = stone
2–3	S. 30° 30′ W.	1500	2 = tree
3–4	N. 50° 30′ W.	150	3 = stone
4–1	N. 30° 30′ E.	1500	4 = stone
1–6–15950	Golden lode = N.	5° 38′ E.	20.6
3–2– 1820	Bear lode = N.	30° 10′ W.	75.8

The cards have all the advantages common to the card system in general, and also the advantage over books, that several people can work in the same office without getting in each other's way by wanting the same volume of

notes at the same time, or having to copy the desired notes out of a book. Then, too, the cards can be taken into the field, and thus copying of notes is avoided. While the skeleton field notes of old claims have to be copied, in the case of new claims the published notes of the claim are simply pasted on the cards, after checking, and afterwards any further information likely to be required is added. The official plats of the claim are also copied and bound up in plat books in every way similar to those in the surveyor general's office, but as a rule without the intersections. On these plats the areas actually patented are colored.

The carbon copies of all field notes made or acquired are bound together. In addition, the connected sheets for these sections required in the Clear Creek and Gilpin districts have been copied in the surveyor general's office and transferred to protractor sheets exactly like those used in that office.

In order to give an idea of larger areas of country than that given by one section, there is also another set of maps in which nine sections are combined in one sheet and the claims colored to show at a glance what area each has patented. These sheets of nine square miles each are arranged in a roller map case.

If ordinary notebooks are used for field notes, they are paged consecutively and card catalogued. Thus, in the system used, page 1213 means notebook, volume 12, page 13.

The writer is at present using a semi-loose-leaf system. The notebook consists of a "filler" of twenty notebook pages, ruled vertically and horizontally. At each end of the book are two pages of cross-section paper. The printed headings are as follows:

Helpers.....

.....

JAMES UNDERHILL, Idaho Springs, Colorado

B. S. station.	Angle.		H. I.	Remarks.
	A. ver.	B. ver.		

The pages are perforated near the binding edge and also punched for loose-leaf binder. In the field the "fillers" are slipped into a leather holder made for the purpose. The book is used as any other notebook, and, when used in the field, has none of the disadvantages of the loose-leaf

At station.	B. S. station.	Angle.		Vert. angle.	Slope dist.	Hor. dist.	Vert. dist.
		A. ver.	B. ver.				

Property.....

Owner .....

Date.....

At station.	Mag. course.	True course.	Vert. angle.	Slope dist.	Hor. dist.	Vert. dist.	To station.

system. When the surveys are completed the leaves are torn out at the perforations. The leaves thus become loose leaves and are filed in loose-leaf binders.

A convenient form for the heading of the ordinary notebook is as follows:

H. I.	Mag. course.	True course.	To station.	Remarks.

All figuring is done on sheets of paper of equal size, and filed, each claim by itself, in congress envelopes.

Carbon copies of all location certificates are filed in an arch letter file.

The Globe-Wernicke and similar filing cabinets afford the best means of preserving these various devices, with the exception of the large plats.

The connected sheets are kept in a case made especially for them.

CHAPTER VIII

EXAMINATION FOR COMMISSION AS UNITED STATES MINERAL SURVEYOR

In Colorado, this examination consists of problems in calculation of closing line in a twelve or thirteen-sided placer, together with calculation of area by Double Meridian Distance Method, calculation of lode line to fit an irregular claim, calculation of ties, intersections and areas in an actual approved survey, together with writing up a complete set of field notes. A problem on the subdivision of a section of the public survey is usually added. The applicant is also required to determine a correct meridian from solar observation and must do this with his own transit. There are, of course, other problems, but they differ in no way from those numerous examples that have been given and explained in the course of this work. A few examples will be given in detail, however, to illustrate special cases. One favorite problem which is of considerable importance is the first one mentioned above, and is as follows:

Placer Calculations

Given. The courses and lengths of lines 1 to 13 of a certain placer. (Fig. 40.) It is desired to amend the survey making Cors. Nos. 2 and 12 identical with the corners of the original survey, the courses of lines 1–2 and 12–13 to remain the same, and the course of line 13–1 to be S. 33° 34′ E., the new placer to contain an area of 35 acres. Required, the lengths of lines 12–13 and 1–2.

Station.	Course.	Distance.	Latitudes.		Departures.		D. M. D.	N. areas.	S. areas.
			North.	South.	East.	West.			
1–2.....	S. 87° 19′ W.	1108.73	.....	51.91	.....	1107.51	1107.51	.....	57490.83
2–3.....	N. 67 50 W.	303.50	114.51	.....	.....	281.07	2496.09	285827.20	.....
3–4.....	N. 77 35 W.	297.00	63.86	.....	.....	290.05	3067.21	195872.00	.....
4–5.....	S. 28 36 W.	796.10	.....	698.96	.....	381.09	3738.35	.....	2612956.90
5–6.....	N. 19 56 W.	905.00	850.78	.....	.....	308.54	4427.98	3767236.90	.....
6–7.....	N. 77 35 W.	145.00	31.18	.....	.....	141.61	4878.13	152100.10	.....
7–8.....	N. 18 41 E.	512.00	485.02	.....	164.01	.....	4855.73	2355125.54	.....
8–9.....	S. 71 08 E.	962.00	.....	311.08	910.32	.....	3781.40	.....	1176317.89
9–10.....	S. 53 05 E.	537.60	.....	322.91	429.82	.....	2441.26	.....	788307.45
10–11.....	S. 88 42 E.	718.50	.....	16.30	718.32	.....	1293.12	.....	21077.71
11–12.....	N. 17 40 W.	633.00	603.15	.....	.....	192.10	766.90	462555.61	.....
12–13.....	N. 70 21 E.	259.04	87.11	.....	243.95	.....	715.05	62288.00	.....
13–1.....	S. 15 46 E.	867.07	.....	834.45	235.55	.....	235.55	.....	196554.71
			2235.61	2235.61	2701.97	2701.97		7281005.35	4852705.49
								4852705.49	
								2)2428299.86	
								1214149.93	sq. ft.

log 1214149.93 = 6.0842721
log 43560.0 = 4.6390879

log 27.873 = 1.4451842

In figuring the missing course and distance of line 13–1, reference should be made to the latitudes and departures

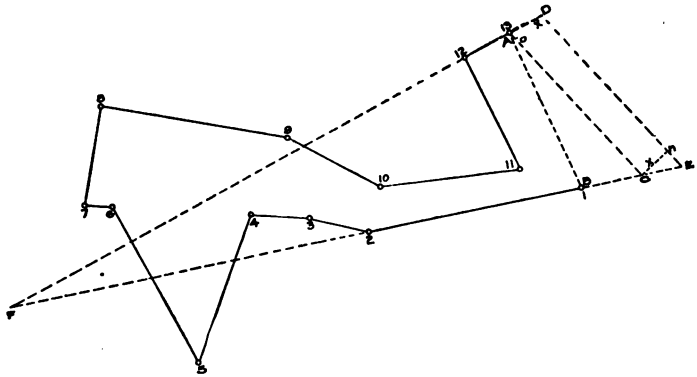


FIG. 40

of courses 1 to 13, included in computing the area by Double Meridian Distances.

The sum of the north latitudes is found to be 2235.61, and the sum of the south latitudes is found to be 1401.16, which latter subtracted from the north latitudes leaves a north latitude of 834.45. In like manner, subtracting the sum of the east departures, 2466.42, from the sum of the west departures, 2701.97, leaves a west departure of 235.55.

log 834.45	= 2.9214003	log 834.45	= 2.9214003
log 235.55	= 2.3720831	log cos 15° 46′	= 9.9833449
log cot 15° 46′	= 0.5493172	log 867.07	= 2.9380554

Missing course = S. 15° 46′ E. 867.07 ft.

In the triangle ABC draw AC parallel to DE, whose course is given as S. 33° 34′ E. Line AB we have found to be S. 15° 46′ E. 867.07 feet.

					A = 17° 48′
A = 33° 34′	B = 87° 19′	C = 33° 34′	180° 00′		B = 103° 05′
15° 46′	15° 46′	87° 19′	120° 53′		C = 59° 07′
17° 48′	103° 05′	120° 53′	59° 07′		180° 00′

sin 59° 07′ : 867.07 = sin 103° 05′ : ?
sin 59° 07′ : 867.07 = sin 17° 48′ : ?

log 867.07	= 2.938054	log 867.07	= 2.938054
log sin 103° 05′	= 9.988578	log sin 17° 48′	= 9.485289
colog sin 59° 07′	= 0.066404	colog sin 59° 07′	= 0.066404
log 984.09	= 2.993036	log 308.85	= 2.489747

Area = ½ (867.07 × 308.85 × sin 103° 05′)

log 867.07	= 2.938054
log 308.85	= 2.489747
log sin 103° 05′	= 9.988578
colog 87120	= −5.059882
log 2.994	= 0.476261

Construct the triangle *ACF*. Line *AF* is a prolongation of line 12–13, and line *CF* is a prolongation of line 1–2.

					A = 103° 55′
A = 70° 21′	*C* = 33° 34′	180° 00′	*F* = 87° 19′		*C* = 59° 07′
33° 34′	87° 19′	120° 53′	70° 21′		*F* = 16° 58′
103° 55′	120° 53′	59° 07′	16° 58′		180° 00′

sin 16° 58′ : 984.09 = sin 103° 55′ : ?
sin 16° 58′ : 984.09 = sin 59° 07′ : ?

log 984.09	= 2.993035	log 984.09	= 2.993035
log sin 103° 55′	= 9.987061	log sin 59° 07′	= 9.933596
colog sin 16° 58′	= 0.534892	colog sin 16° 58′	= 0.534892
log 3273.32	= 3.514988	log 2894.17	= 3.461523

Area = ½ (984.09 × 2894.17 × sin 103° 55′)

log 984.09	= 2.993035
log 2894.17	= 3.461524
log sin 103° 55′	= 9.987061
colog 87120	= −5.059882
log 31.732	= 1.501502

The area of the placer was found to be 27.873 acres. The area of the quadrilateral *ADBE* is therefore the difference between 35 acres, the required acreage, and 27.873

acres, which is 7.127 acres. The area of the triangle ABC was found to be 2.994 acres; then the area of the quadrilateral $ADCE$ is the difference between 7.127 acres and 2.994 acres, or 4.133 acres. The area of the triangle ACF has been found to be 31.732 acres. Therefore the area of the triangle DEF is 31.732 acres + 4.133 acres, or 35.865 acres.

By geometry —

$31.732 : 984.09^2 = 35.865 : DE^2$
$31.732 : 3273.32^2 = 35.865 : EF^2$
$31.732 : 2894.17^2 = 35.865 : DF^2$

$\log 984.09^2$	$= 5.986070$	$\log 3273.32^2$	$= 7.029978$
$\log 35.865$	$= 1.554671$	$\log 35.865$	$= 1.554671$
	7.540741		8.584649
$\log 31.732$	$= 1.501502$	$\log 31.732$	$= 1.501502$
	$2)6.039239$		$2)7.083147$
$\log 1046.21$	$= 3.019619$	$\log 3479.95$	$= 3.541573$
$\log 2894.17^2$	$= 6.923046$	DF	$= 3076.86$
$\log 35.865$	$= 1.554671$	AF	$= 2894.17$
	8.477717	AD	$= 182.69$
$\log 31.732$	$= 1.501502$		
		EF	$= 3479.95$
	$2)6.976215$	CF	$= 3273.32$
$\log 3076.86$	$= 3.488107$	EC	$= 206.63$

BC	$= 308.85$	1–2	$= 1108.73$	12–13	$= 259.04$
EC	$= 206.63$	BE	$= 514.48$	AD	$= 182.69$
BE	$= 514.48$	E–2	$= 1623.21$	12–D	$= 441.73$

Another method of working this problem is as follows: The area of the quadrilateral $ADCE$ has been found as in the previous figuring. The following formula will give the altitude:

Let x = altitude
Let $K = \cot E - \cot A$

Let A = area of $ADCE$ (4.135 acres = 180,033 sq. ft.)
Let D = 984.09 ft. (line AC)

$$x = \frac{1}{K}\left(\pm\sqrt{2AK + D^2} - D\right)$$

nat cot 59° 07′ = 0.59809	log 984.09 = 2.9930348
nat cot 76° 05′ = 0.24778	log to square = 2.9930348
K = 0.35031	log 968433.12 = 5.9860696

$$x = \frac{1}{0.35031}\left(\sqrt{2 \times 180033 \times 0.35031 + 968433.12} - 984.09\right)$$

log 200 = 0.3010300	126135.00
log 180033.00 = 5.2553533	D^2 = 968433.12
log 0.35031 = −1.5444525	1094678.12
log 126135 = 5.1008358	

The square root of 1,094,678.12 is found as follows:

log 1094678.12 = 6.0392436	1046.21
2)6.0392436	984.09
3.0196218 = log 1046.21	62.12

log 62.12 = 1.793231	
log 0.35031 = −1.544452	
log 177.33 = 2.248779 = x	

In the right triangle ADo, we have Do = 177.33 feet, the angle D = 70° 21′ − 56° 26′ = 13° 55′.

log 177.33 = 2.248779	log 177.33 = 2.248779
log tan 13° 55′ = 9.394073	log cos 13° 55′ = 9.987061
log 43.94 = 1.642852	log 182.69 = 2.261718

It is seen here that line AD, 182.69, checks with the former work.

In the right triangle CEn, we have Cn = 177.33 feet, and the angle E = 59° 07′.

log 177.33 = 2.248779	log 177.33 = 2.248779
log cot 59° 07′ = 9.776769	log sin 59° 07′ = 9.933596
log 106.06 = 2.025548	log 206.62 = 2.315183

Line *CE*, 206.62, also checks line *CE* in the first method.

984.09 = *AC*
43.94 = *Ao*

940.15 = *oC* = *Dn*
106.06 = *nE*

1046.21 = *DE*

Calculation of Lode Line

Given the boundaries of a claim, calculate the lode line parallel to the side lines, and the points at which the lode line intersects the end lines. No point on the lode line to be in excess of 150 feet from either side line. Lode line to be 1,500 feet long.

The boundaries are as follows: Beginning at Cor. No. 1, thence E. 702 ft. to Cor. No. 2; thence S. 58° E. 800 ft. to Cor. No. 3; thence S. 30° W. 300 ft. to Cor. No. 4; thence N. 58° W. 800 ft. to Cor. No. 5; thence W. 702 ft. to Cor. No. 6; thence N. 30° E. 300 ft. to Cor. No. 1, the

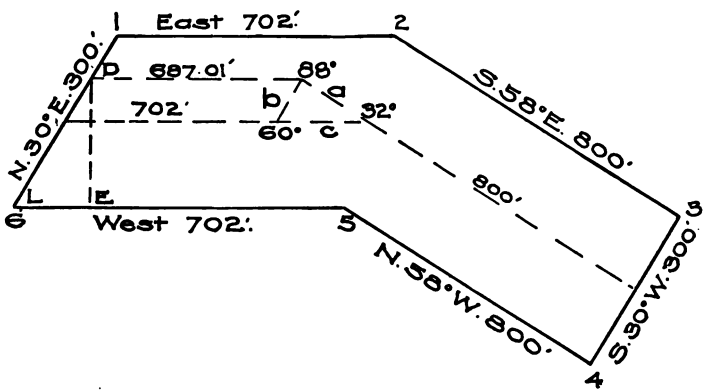


FIG. 41

place of beginning. (See Fig. 41, which shows conditions necessarily greatly exaggerated.) The side b is drawn

parallel to the end lines in the triangle whose sides are a, b and c.

$$800 + a + 702 - c = 1500$$
$$1502 + a - c = 1500$$
$$c - a = 2$$

$$c = \frac{a \sin 88^\circ}{\sin 60^\circ}$$

$$\frac{a \sin 88^\circ}{\sin 60^\circ} - a = 2$$
$$a \sin 88^\circ - a \sin 60^\circ = 2 \sin 60^\circ$$
$$a = \frac{2 \sin 60^\circ}{\sin 88^\circ - \sin 60^\circ}$$

$\sin 60^\circ = 0.86603$
2
1.73206

$\log 1.73206 = 0.238698$
$\log 0.13336 = -1.125025$
$\log 12.99 = 1.113673$

$\sin 88^\circ = 0.99939$
$\sin 60^\circ = 0.86603$
0.13336

In the triangle whose side a we have found to be 12.99 the sides b and c are found as follows:

$\sin 60^\circ : 12.99 = \sin 32^\circ : ?$
$\sin 60^\circ : 12.99 = \sin 88^\circ : ?$

$\log 12.99$	$= 1.113673$	$\log 12.99$	$= 1.113673$
$\log \sin 32^\circ$	$= 9.724210$	$\log \sin 88^\circ$	$= 9.999735$
$\operatorname{colog} \sin 60^\circ$	$= 0.062469$	$\operatorname{colog} \sin 60^\circ$	$= 0.062469$
$\log 7.95$	$= 0.900352$	$\log 14.99$	$= 1.175877$

$$800 + 12.99 + 702 - 14.99 = 1500 = \text{lode line}$$

800.0	702.0	687.01
12.99	14.99	812.99
812.99	687.01	1500.00

The distance of the lode line at its intersection with *line 6–1 is* found to be 157.95 feet from Cor. No. 6, and

142.05 feet from Cor. No. 1, by adding the distance 7.95 feet (*b*) in one case, and subtracting in the other, to and from 150 feet.

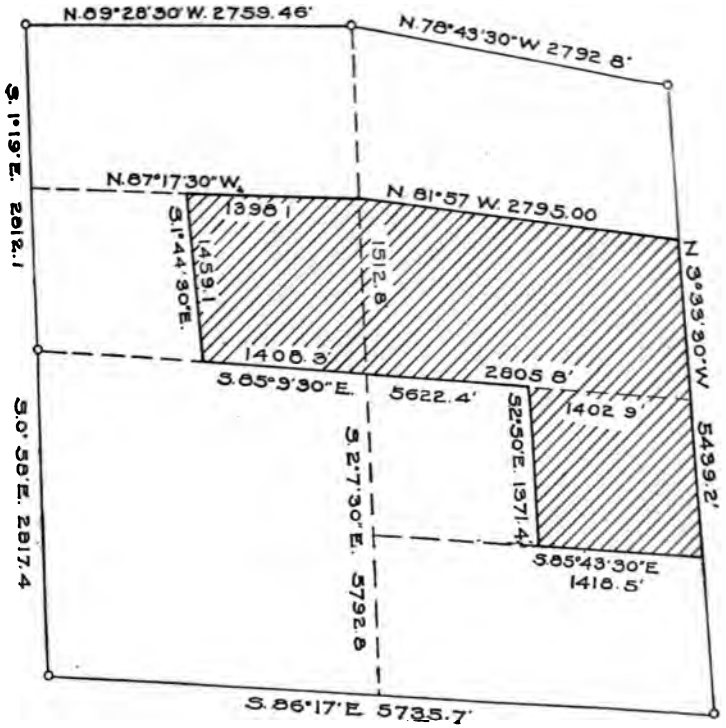


FIG. 42

In the triangle *DEL* draw *DE* perpendicular to the side line. Multiplying the side *LD* (157.95) by the sine of the angle *L*, 60°, we get the distance of the lode line from line 5–6, which is 136.80 feet.

Subdivision of Section

Given the boundaries of a section (Fig. 42) to determine the boundaries of the S. E. $\frac{1}{4}$ of the N. W. $\frac{1}{4}$, the S. $\frac{1}{2}$ of the N. E. $\frac{1}{4}$ and the N. E. $\frac{1}{4}$ of the S. E. $\frac{1}{4}$ sections.

S.	86° 17′	E.	5735.7 feet.
N.	3° 33′ 30″	W.	5439.2 feet.
N.	78° 43′ 30″	W.	2792.8 feet.
N.	89° 28′ 30″	W.	2759.46 feet.
S.	1° 19′	E.	2812.1 feet.
S.	0° 58′	E.	2817.4 feet.

General Figuring

In Fig. 43 we have an example of a problem given the writer in his examination for a commission as United

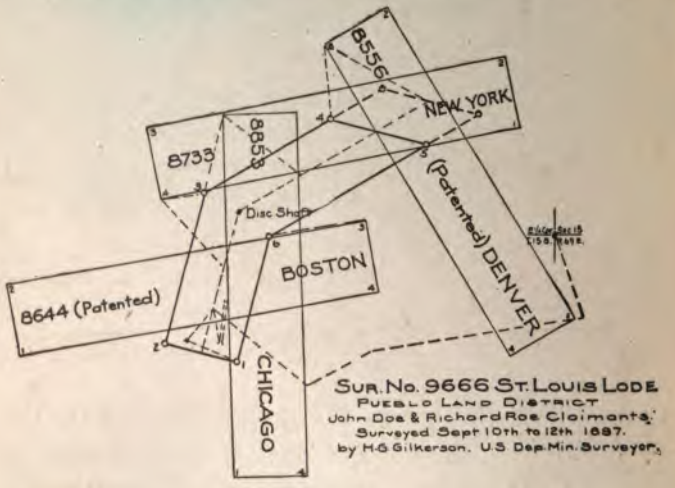


FIG. 43

States deputy mineral surveyor. Given the boundaries *of the* conflicting claims, the traverse as made on the *ground,* of lode line of St. Louis Lode, and the ties to con-

flicting claims, section corner and improvements, calculate boundaries of St. Louis Lode (cutting off at intersection of end line with Sur. No. 8556 Denver Lode), section tie directly, ties to conflicting claims, and conflicts in each case, also ties to improvements. Then write up the notes, giving imaginary bearings from corners and imaginary dimensions to improvements. Do not exclude Surs. Nos. 8733 and 8853, New York and Chicago lodes, and state why.

South Dakota *

Following is a partial list of questions asked in South Dakota:

1. I run 360 feet on a descent of 1 foot in 15 feet, thence 240 feet on an ascent of 11° from the horizontal, thence 400 feet on a descent of 1 foot in 16 feet, thence 250 feet up an ascent of 35°.

Required total horizontal distance, also difference of level of the initial and terminal points. State a full solution with sketch.

2. From initial point I run S. 12° E. 650 feet, and am intercepted by a pond. From 650-foot point I run S. 82° E., a distance sufficient to clear pond, thence S. 28° W. 420 feet to flag on line in advance of pond, thence S. 12° E. 460 feet to terminal point.

Required the length of line from initial to terminal point. State a full solution with sketch.

3. I run S. 38° E. and at 380 feet turn off a base N. 82° E. 520 feet, from the eastern extremity of which a flag on line in advance of river bears S. 8° E.

What is the distance of flag from initial point? State a full solution with sketch.

* These questions kindly furnished by Professor Mark Ehle, Rapid City, South Dakota.

4. Course No. 2 of Delta mining claim is broken into by a rock bluff, unfavorable to accurate chainage. To obtain the bearing and length of this line, I run from one extremity on a random line S. 28° E. 610 feet, thence N. 82° E. 260 feet, thence S. 12° W. to a point which from the data so far obtained I find to be on my random line; thence I continue the first random 340 feet farther and arrive at a point from which the other extremity of said course No. 2 bears S. 62° W., 110 feet distant.

What is the bearing and length of course No. 2? What angle do I deflect from the course S. 12° W. in order to line in with the first random? State a full solution with sketch.

5. The two extremities of a straight line forming a portion of the boundary of a mining claim are not conveniently accessible, but a convenient base can be had, from each extremity of which both extremities of said boundary can be seen.

1st. Illustrate this condition with sketch.

2nd. State the measurements, both linear and angular, which are absolutely essential to a solution.

3rd. State briefly the trigonometric solutions and their respective purposes, with their respective formulæ.

4th. Trace the process to a final resulting course and distance.

A numerical example is not asked.

6. State a convenient formula applicable to what is known as a "broken base," using the number of minutes in the deflection angle of the second component.

7. Given the following consecutive courses of a mining claim:

From Cor. No. 1 to Cor. No. 2, = S. 28° 40′ W. 503 feet;
From Cor. No. 2 to Cor. No. 3, = N. 70° 30′ W. 476 feet;

From Cor. No. 3 to Cor. No. 4, = N. 9° 35′ E. 485 feet;
From Cor. No. 4 to Cor. No. 5, = ? 343 feet;
From Cor. No. 5 to Cor. No. 1, = N. 79° 50′ E. ? feet;

1st. Required bearing of line 4–5 and length of line 5–1.

2nd. If by actual survey of all the sides, it is found that the line 5–1 is N. 79° 55′ E. 395 feet, state a traverse showing the closing errors; then

3rd. Balance the survey on the assumption that the measurements have equal weights.

4th. Deduce the resulting courses and distances of the closing survey for record.

5th. Compute the area of the figure so enclosed, by the method of D. M. D. State full solution with sketch.

8. An incline descends on a dip of 30°. It is determined to sink a shaft to intercept incline, the shaft to be at a point 450 feet from mouth of incline; the surface from mouth to shaft descending at a rate of 1 foot in 75.

How deep will the shaft be?

9. What is azimuth?

10. Observe Polaris at greatest elongation at a place in latitude 45° 30′ N. Apparent of the star is 88° 44′ 10″.

What is the star's azimuth?

State the formula and whole process.

What are the two hour angles corresponding to eastern and western elongations respectively, counting from culmination, round with the sun to 24 hours, and their equivalents in mean solar time?

11. If in the last example the star is observed at eastern elongation and its magnetic bearing at that instant is N. 13° 20′ W.

What is the magnetic declination?

Is it to be called East or West?

State process and reason therefor.

12. U. S. Revised Statutes (2320) limit lode claims located after May 10, 1872, to 300 feet on each side of the middle of the vein at the surface; suppose you were called upon to make an official survey of such a location under order from this office, and found it to be 350 feet on each side of the middle of the vein at the surface, and you found nothing in the location certificate to dictate to the contrary; what would be your action in respect to such a location? Why? Suppose such a location was 200 feet on one side of the vein and 400 feet on the other; what would your action be? Why?

13. A lode claim located since May 10, 1872, shows a length of 1,529 feet along the center of the vein at the surface. What would be your action in this case? Why?

14. The boundaries of a lode location have the following consecutive courses, namely:

S. 42° W. 800 feet;
S. 22° W. 600 feet;
N. 80° W. 90 feet;
S. 62° W. 200 feet;
N. 22° E. 600 feet;
N. 42° E. 800 feet;
N. 62° E. 190 feet; thence to place of beginning.

What would your action be on this location if required to make an official survey? Why?

15. I run N. 89° 56′ W. on a random line between Secs. 30 and 31, and at 73.20 chains intersect the west boundary of township at a point 22 links north of the corner of Secs. 25, 30, 31 and 36.

1*st.* What is the course of the return or true line?

2*nd.* The position of the $\frac{1}{4}$ section corner?

3*rd.* State a short rule for obtaining the return course in these cases, applicable when the fallings are within *limits*, and apply to the above case.

16. An order to officially survey a mineral claim is issued to you from this office under date March 12, 1900; said order is based upon a location certificate dated January 10, 1899. Upon proceeding with survey, you find the location as marked on the ground does not conform to the location as recorded, and upon informing your client to that effect he provides you with a certified amended certificate of location dated March 30, 1900.

What action would you take in the matter of survey?

17. Describe fully your instrument, stating its make, age and condition; also its capabilities as to power, illumination and graduation, and its attachments of convenience for safe and accurate work.

What measure of length have you?

18. If your telescope has a level, state briefly in writing how you would adjust it and the horizontal hair.

19. The usual method for adjusting the vertical hair in a transit for collimation, may or may not place that hair truly in the center of the telescope. In a well constructed instrument the displacement will be small; in such case, what sensible effect has this displacement upon observations, seeing that the motion of the slide will not project this hair truly along the axis of the telescope?

20. It is required that you determine the true meridian by direct solar observation. You will make the observation in the presence of the examiner, who will then furnish you with a copy of the nautical almanac. From the data then at hand you will make all necessary calculations, handing in the same complete.

21. In latitude 30° N. the sun's declination 20° S. with hour angle 5 hours; the refraction in declination is 8′ 50″.

Assuming no index error, which would be the correct

reading to set off on the declination arc, proper for the above date?

22. In latitude 44° N. the hour angle of the sun 6 hours, I start a line due north by solar; but find after running a mile in the course so started, that I have set off 6′ too much latitude.

What is the nature and amount of error in course thus induced?

If in the above the hour angle is 3 hours, what is the nature and amount of error?

If the latitude is correctly set off, but instead of a declination of 10° S., I set off 10° 10′ S., the hour angle of the sun being 3 hours, what then is the nature and amount of the error thus introduced?

State, if you can, the differential formulæ applicable to these cases.

California *

The customary manner of appointment in this and the adjoining states is as follows:

"The surveyor who wishes an appointment, makes application to the surveyor general, detailing his qualifications. This application, together with the recommendation from some mineral surveyor of good standing within that district, is then forwarded to the surveyor general's office, and in due time the appointment is made. The customary filing of the bonds completes the appointment of the United States mineral surveyor.

"If the surveyor desires an appointment in any other state or territory, a recommendation from the surveyor general of the state in which the original appointment was *made is all* that is necessary. Of course, new and separate

* *Kindness* of Henry J. Jory, Los Angeles, California.

bonds must be filed for each state or territory in which commission is held."

Oregon *

The examination in Oregon is about as follows:

1. Fifteen or twenty questions covering the Land Office rulings, the proper markings for corners of government land surveys, the methods of taking latitude by the sun and Polaris, the maximum number of acres allowed in quartz claim, placer and mill site, the kind of corners which may be set in making patent surveys, and various details of procedure in executing such surveys.

2. Given the notes of a quartz claim (metes, bounds and ties) and the location of the same, make out notes and preliminary plat of same as if surveyed for patent. This is the office work that the deputy will have to do in making an actual survey.

3. Given the plat of the locations of four claims forming one group, and overlapping each other, with a section corner located on one of the center ones (this plat is furnished by the surveyor general), make out notes of a survey for U. S. patent of the group, with plat, calculations, etc. The claims are given on the plat furnished as longer than 1,500 feet and wider than 600 feet, so there is a test of ability in getting them within the required limits and at the same time not leaving any fractions.

4. An instrumental examination. Applicant is required to take a transit and determine latitude and meridian by sun and Polaris, checking upon an established meridian, and also to report the courses from a given point to a number of points whose bearing is known.

Parts 2 and 3 are severe tests of applicant's ability, and

*From H. G. Moulton, U. S. Deputy Mineral Surveyor, Grant's Pass, Oregon.

the examination as a whole is an exceedingly thorough one. It is the aim of the office to get the best available men of the state as surveyors, and the examination is in every way a fair one and free from "catch" questions.

While this is all the information that the writer has been able to obtain on the subject of examinations for commission as United States mineral surveyor, it is safe to say that in no state is the examination more difficult than in Colorado or Oregon. If the applicant is able to pass the examination in either of these two states, the chances are that he will be able to pass in any state where an examination is held.

THE PATENTING OF MINERAL LAND*

The layman who desires to secure United States patent on his mining property is not always cognizant of the proper procedure and approximate expense involved, and frequently either delays action, fearing that the matter is more formidable than it really is, or else takes unwarranted steps due to his ignorance of the conditions involved. The following forms have been devised by me with a view of obviating the above-mentioned difficulties, and I claim that they put the matter of patents in as concise and, at the same time, as complete a form as the laity can desire.

Preliminary Steps in Obtaining United States Patent to Mineral Claims

1. Obtain from the county recorder a certified copy of the location notice of each claim upon which patent is sought.

2. *Deposit* in any United States depository to the credit

* Kindness of Henry J. Joy, Los Angeles, California.

of the Treasurer of the United States a sum sufficient to cover the expenses of the work in the surveyor general's office. In this state this is $.....* for lode claims, and $.....* for placers, with reduction for groups.

3. Forward the certified copies of location notices, together with the duplicate certificate of deposit to the United States surveyor general at ....., together with an application for official survey upon a blank issued by the general land office for this purpose, a copy of which may be had at this office.

4. In due time the surveyor general issues to the mineral surveyor named in the application, a survey order, in which a serial number is given to the particular survey authorized. This is the surveyor's warrant for entering upon any lands necessary in order to make the survey. No survey is official unless in pursuance of an order from the surveyor general of the district.

5. The United States mineral surveyor designated thereupon makes a complete survey of the premises, locating and fixing the corners of all the claims, locating the discovery points, all the shafts, cuts, tunnels, buildings, and machinery, with reference to the nearest corner of the claim. Also runs ties to the nearest section corners, or quarter-section corners, or if upon unsurveyed land, then to the nearest mineral monument. Assistants must be sworn in to faithful service both before and after the survey, before an officer qualified to administer oaths. Neither the claimants themselves, nor agents thereof, may act as assistants in mineral surveys. An underground survey must generally be made in order to plat the same upon the map, in plan only. All corner stones or posts must be up to government standard, and chiseled or scribed with the claim initials, number of corner and survey number.

6. *Plat and Field Notes from the Mineral Surveyor to the Surveyor General.* — These very commonly take double the time of the actual field work, as they must be prepared with absolute accuracy and fidelity to detail as required by the department. They must show, in addition to the data previously mentioned, the distances intersected on all the section lines, complete calculation of areas by double meridian distances, the sectional subdivisions made fractional, the errors found in previous contiguous surveys, and many other minor details.

7. *Examination of the Above by the Surveyor General.* — The returns by the mineral surveyor must await their turn in the surveyor general's office before coming up for approval. This may take two or three months, or longer. The returns are then examined by a skilled force of clerks and deputies, all calculations, ties, boundaries, intersections, etc., are rechecked, and the notes and plat searched for irregularities. If any are found, the notes are returned to the surveyor for correction, and when again received, must generally await their turn for approval. In extreme cases it has taken several years to obtain the approval of a survey. Three months is about the average time.

8. Upon the approval of the survey, the surveyor general prepares an approved copy of the plat for claim in the survey, and three extra copies. One copy is retained, one forwarded to the General Land Office at Washington, one to the local land office, and the other, with transcript of the field notes, is returned to the claimants. Each plat contains the official approval of the surveyor general and his certificate of $500 improvements, as returned by the mineral surveyor.

Upon receipt by the claimants or their attorneys of the *plats and* transcripts, the matter is in shape for the patent *application* proper.

Method of Procedure in Patent Applications for Lode Claims

Upon receipt of the approved plats and transcript of notes from the surveyor general, these are turned over to the attorney engaged to prepare the necessary papers in the case. (United States mineral surveyors are not allowed by the rules of the department to act as attorneys in mineral cases.)

1. There is prepared the **notice of application for United States patent,** according to the specified form, describing the ground claimed. This is prepared in triplicate, and one copy, attached to the plat and transcript of notes, is at once posted on the claim in the presence of two witnesses.

These witnesses then subscribe to this posting before notary public, in the form specified for **proof of posting notice and the diagram of the claim.** They also attach their names as witnesses to the **notice of application for patent.**

2. There is then prepared by the attorney the following papers, constituting the **first set.**

Application for patent in regular form and describing premises.

The abstract of title. (This must be shown to be in applicant.)

The proof of citizenship. (Affidavits showing applicant to be United States citizen.)

Proof of non-abandonment, i.e., that assessment work was done for year preceding the application.

Agreement of publisher. (That he will not hold United States responsible for costs.)

Publication notice. (This is identical with notice of application for patent, except that it is not signed by appli-

cant, but left blank for signature of the register of the district.)

3. These papers, together with the extra plat, transcript of notes, and the **proof of posting,** are then filed with the register of the land district, who attaches his signature and the serial number of the **publication notice,** and either delivers same to the attorney or forwards it direct to the printer.

4. This publication notice is published for sixty-one consecutive days in a daily, or nine consecutive times in a weekly newspaper. During this time plats, notices and transcripts must **remain posted.**

5. After expiration of period of publication, attorney prepares the **second set** of papers, as follows:

Proof of continuous posting (by two witnesses before notary).

Proof of publication (certificate from the publisher, giving dates and number of times published).

Proof of no suit pending (attested by clerk of county wherein claims exist).

Proof of sums paid (made by applicant, detailing amounts paid to surveyor, the filing fees, publisher's account, and amount tendered **received** for acreage.)

Formal **application to purchase.**

The filing of this paper completes the requisites of entry and payment and the register's **proof of posting notice,** and final certificate of entry completes the patent application.

All papers except a copy of the plat are forwarded by the local land office to the department at Washington and patent is issued within one year, except when the department is overcrowded.

No assessment work need be done after the issuance of the receiver's receipt.

The government price for lode claims is $5 for each acre or fraction thereof.

All affidavits must be made before an officer legally qualified to administer oaths, and, with few minor exceptions, must be made within the land district.

A corporation may apply, if its citizenship is properly supported. Alien corporations may not patent, and sums paid by them are forfeited.

Receiver's receipt is obtained six to eight months after survey.

Any other details desired can be supplied.

Estimate to Claimant Not to Be Made by the Mineral Surveyor

As per request I am pleased to submit you a detailed estimate of the minimum cost of obtaining United States patent to the following mining claims, viz.: ..... together with a general statement of the method of procedure, which may serve to guide you in the matter.

1. (.....) Certified copies of the location notices — one for each claim — to be obtained from the county recorder at .....† and forwarded to the United States surveyor general at .....‡ together with an application for official survey, drawn up on a special blank, which can be furnished by this office. This must be signed with the name and address of applicant or his attorney. $.....*

2. This application must be accompanied by a certificate of deposit from any bank, designated as a United States depository, showing that there has been deposited by the claimant, to the credit of the treasurer of the United States, a sum sufficient to cover the cost of office work on plats, transcripts, etc., in the surveyor general's office. ‡

this state the cost is $.....* for the first claim, and $.....* for each successive claim or fraction. Total, $.....*

No survey order will be issued unless money is deposited and unless application is accompanied by satisfactory location certificates. (See special sheet in regard thereto.)

3. Official survey by United States mineral surveyor, including all expenses for traveling, assistants, incidentals, notary fees (all assistants appearing twice under oath in addition to their affidavit of improvements), also all office work on plats and field notes, and full returns to the surveyor general until the final approval of the survey. $.....*

4. Attorney work, preparation of the patent application and all papers in the case, as listed in the circular entitled "Method of Procedure," including the taking of affidavits and all notary fees. $.....*

5. Abstract of title, as shown by the records of the county recorder, cost depending upon number of claims, number of transfers, etc., and very variable. In this case about $.....*

6. Publication of the notice of application for patent. This must be advertised in the nearest newspaper to the claim, satisfactory to or designated by the register of the local land office. Amount charged is very variable and is a matter for special contract. About $.....*
Sixty-one consecutive days in daily, or nine consecutive weeks.

7. Fees for filing application for patent at the district land office, in this case at .....§
Payment must be made to the receiver when first set of papers are filed. $.....*

8. Proof of posting plats, etc., and proof that plats, etc., have remained posted. Two witnesses must in each case subscribe to these affidavits. Cost is very variable, depending on distance witnesses must cover in going to claim and to notary. About $.....*

9. Certificate of no suit pending, proof of non-abandonment, proofs of sums paid, and miscellaneous affidavits, if necessary. About $.....*

10. Purchase price from United States government for the land. Amount to be paid to the receiver of the district land office by the claimant for the acreage as returned by the mineral surveyor. Fractional acres are charged as full acres. Rate is $5 per acre for lode claims and mill sites and $2.50 per acre for placers. About ..... acres at $.....*

Estimated total, $.....*

If any adverses or protests be filed, costs are at once increased largely, and no approximate estimates can be made.

Notation to Accompany Surveyor's Estimate

Many of the ordinary location notices upon which claims are held are not deemed "sufficient" by the surveyor general, and survey orders will not be issued upon them without amendment.

Satisfactory location certificates must in general be drawn up after a certain recognized government form, and state with great explicitness the locality and boundaries of the claim. The surveyor general is authorized to refuse

* To be filled in in accordance with the list of charges adopted by the surveyors general in each state or territory.

† County in which claim is located.

‡ Capital of state or territory.

§ Land district office in state or territory.

survey orders on notices that are vague, indefinite, faulty, or that will not serve to fix the boundaries of the claim upon the public domain.

Furthermore, the surveyor is expressly prohibited from including any ground outside of the original boundaries of the claim, even though said ground may be vacant at the time of survey, and neither side line may be over 300 feet distant from the middle of the vein at the surface. Any attempt to evade these requirements will probably cause a disapproval of the survey. Even if they are successfully evaded in the plat and field notes, the entire application is subject to protest and cancellation in the land office.

This last requirement, together with the well-recognized principle that the end lines must be made parallel, often serves to cut off ground from the claim which cannot be included in the patent application.

Very often this ground is valuable and must be made the subject of another survey and application, with its attendant cost.

It is, therefore, **generally advisable,** in all cases where claims have not already been surveyed for amended location, to make a preliminary survey of the claims, taking up all fractions and vacant ground, shifting the original locations, if necessary, so that the side lines and discovery point present the proper relations to each other. Formal amended certificates are then filed, disposing of the ground in exactly the manner desired in the patent. A survey order may at once be obtained from these certificates, and a survey based upon such re-location generally meets with prompt approval.

None whatever of the original rights are lost by this

amendment, but, on the contrary, this simple procedure does away with nearly all of the protests, adverses, apex litigation, and other difficulties attendant upon the exercise of mining rights.

H. J. JORY.

APPENDIX

The following extracts are from the

MANUAL OF INSTRUCTIONS FOR THE SURVEY OF THE MINERAL LANDS OF THE UNITED STATES

Washington: Government Printing Office, 1909.

DEPARTMENT OF THE INTERIOR
General Land Office,
Washington, D. C., September 11, 1908.

To United States Mineral Surveyors.

Sirs: These regulations are chiefly compiled from the practice of the various surveying districts, no changes or additions being made, except where necessary to secure uniformity and to conform to present interpretations of the law.

You are expected to strictly comply with these instructions, and no survey will be accepted or approved by the surveyor general until all the requirements herein have been fully met.

Very respectfully,

FRED DENNET,
Commissioner.

Approved, October 6, 1908.
FRANK PIERCE,
First Assistant Secretary.

GENERAL INFORMATION

Appointments

1. Under section 2334, United States Revised Statutes, the United States surveyor general "may appoint in each land district containing mineral lands as many competent surveyors as shall apply for appointment *to survey mining* claims."

2. Capable persons desiring such appointments should therefore file their applications with the surveyor general for the district wherein appointment is asked, who will furnish all information necessary.

3. Mineral surveyors may, at the same time, be appointed in more than one State or land district. (20 L. D., 163.)

4. The surveyors general have authority to suspend or revoke the appointments of mineral surveyors for cause. The surveyors, however, will be allowed the right of appeal from the action of the surveyor general in the usual manner. The appeal must be filed with the surveyor general, who will at once transmit the same, with a full report, to the General Land Office. (20 L. D., 283.)

5. Neither the surveyor general nor the Commissioner of the General Land Office has jurisdiction to settle differences, relative to the payment of charges for field work, between mineral surveyors and claimants. These are matters of private contract and must be enforced in the ordinary manner, i.e., in the local courts. The department has, however, authority to investigate charges affecting the official actions of mineral surveyors, including combinations to fix prices for survey work, and will, on sufficient cause shown, suspend or revoke the appointment of the surveyor.

6. Where error in the original survey appears to be the fault of the mineral surveyor who made the survey, he should be required to make the necessary corrections in the field as speedily as practicable; and upon his failure or refusal, without satisfactory reason, to comply with instructions within a specified time, he should be called upon to show why his appointment should not be suspended or revoked for willful neglect or incompetency. In the event he fails or refuses to comply with the instructions, the mineral claimant will be notified and given a reasonable time to apply for an amended survey.

7. These instructions are subject to the limitations of section 2324, United States Revised Statutes, so far as the same refers to local laws and customs.

8. The Commissioner of the General Land Office is ex-officio United States surveyor general for Arkansas and Florida, and all surveys in Oklahoma are made under his direction as Commissioner.

Bonds

9. All bonds of mineral surveyors must be submitted to the Commissioner of the General Land Office for approval.

10. The appointment of a mineral surveyor is not for any fixed period, the continuation thereof depending upon the character of the service rendered. The surveyor general will, therefore, not appoint mineral surveyors for a specified term. While under the act of March 2, 1895 (28 Stat., 807), mineral surveyors' bonds are examined every two years as to their suffi-

ciency, and new bonds required every four years from their dates, the latter requirement is not because the term has then expired.

11. A mineral surveyor is not authorized to perform any work under his appointment until his official bond shall have been accepted by the Commissioner of the General Land Office. The bond shall be in a sum not less than $5,000, and will become effective, and the liability of the principal and surety will begin, with the acceptance of the bond by the Commissioner.

12. Bonds cannot be cancelled, nor can the surety thereto withdraw, to the extent of relieving the surety of liability for defaults during the time the principal performed his duties thereunder. The most that may be done is to relieve the surety of future responsibility by requiring a new bond, or by the retirement from office of the principal, by formal notice from the Commissioner of the General Land Office.

13. Mineral surveyors' bonds will be examined every two years by the surveyor general as to their sufficiency, and every four years such bonds shall be renewed as provided by the act of March 2, 1895 (28 Stat., 807). Only corporate sureties will be accepted.

14. If at any time the surveyor general deems the surety on a bond insufficient, he will report the matter to the Commissioner of the General Land Office for instructions, notifying the mineral surveyor of his action, and the mineral surveyor will be required to renew his bond within sixty days under penalty of revocation of his appointment, unless satisfactory explanation of delay is offered therefor. Unsatisfactory service, also, will be deemed sufficient cause for a revocation of an appointment, but the surveyor general's action therein, subject to appeal, will require the approval of the Commissioner of the General Land Office.

15. The acceptance of a bond will be based upon an evident desirability or necessity therefor, and, prior to an acceptance of such bond, the principal will be required to make satisfactory explanation to the surveyor general, supporting his tender of same.

INSTRUCTIONS TO MINERAL SURVEYORS

General

1. All official communications must be addressed to the surveyor general. You will always refer to the date and subject-matter of the letter to which you reply, and when a mineral claim is the subject of correspondence, you will give the name and survey number.

2. You should keep a complete record of each survey made by you, and of the facts coming to your knowledge at the time, as well as copies of all your field notes, reports, and official correspondence, in order that

such evidence may be readily produced when called for at any future time.

3. Field notes and other reports must be written in a clear and legible hand, or typewritten, in non-copying ink, and upon the proper blanks gratuitously furnished you by the surveyor general's office upon application. **No interlineations or erasures** will be allowed, and no abbreviations or symbols must be used, except such as are indicated in the specimen field notes.

4. No return by you will be recognized as official unless it is over your signature as a United States mineral surveyor and made in pursuance of a special order from the surveyor general's office. After you have received an order for survey, you are required to make the survey and return correct field notes thereof to the surveyor general's office without delay.

5. The claimant is required, in all cases, to make satisfactory arrangements with you for the payment for your services and those of your assistants in making the survey, as the United States will not be held responsible for the same. You will call the attention of applicants for mineral-survey orders to the requirements of paragraph 12 of the circular, Appendix A. (Sec. 2334, U. S. Rev. Stats., par. 90, Mining Circular, May 21, 1907.)

6. You will promptly notify the surveyor general's office of any change in your post office address. (20 L. D., 163.)

7. You are precluded from acting, either directly or indirectly, as attorney in mineral claims. Your duty in any particular case ceases when you have executed the survey and returned the field notes and preliminary plat, with your report, to the surveyor general. You will not be allowed to prepare for the mining claimant the papers in support of his application for patent, or otherwise perform the duties of an attorney before the land office in connection with a mining claim. You are not permitted to combine the duties of surveyor and notary public in the same case by administering oaths to the parties in interest. It is preferable that both preliminary and final oaths of assistants should be taken before some officer duly authorized to administer oaths, other than the mineral surveyor. In cases, however, where great delay, expense, or inconvenience would result from a strict compliance with this rule, you are authorized to administer the necessary oaths to your assistants, but in each case where this is done, you will submit to the proper surveyor general a full written report of the circumstances which required your stated action; otherwise you must have absolutely nothing to do with the case, except in your official capacity as surveyor.

The Field Work

8. The survey made and reported must, in every case, be an actual survey on the ground in full detail, made by you in person after the receipt

of the order, and without reference to any knowledge you may have previously acquired by reason of having made the location survey or otherwise, and must show the actual facts existing at the time. This precludes you from calculating the connections to corners of the public survey and mineral monuments, or any other lines of your survey through prior surveys, unless it is satisfactorily shown in your report that you have retraced such lines and found them to be correct. (6 L. D., 718; 7 L. D., 81.)

The term **survey** in these instructions applies not only to the usual field work, but also to the examinations required for the preparation of your affidavits of $500 expenditure, descriptive reports on placer claims, and all other reports.

Survey and Location

9. The survey of a mining claim may include several contiguous locations owned in common, but such survey must, in conformity with statutory requirements, distinguish the several locations, and exhibit the boundaries of each. (5 L. D., 199; 6 L. D., 808; 29 L. D., 585.)

10. The survey must be made in strict conformity with, or be embraced within, the lines of the location upon which the order is based. If the survey and location are identical, that fact must be clearly and distinctly stated in your field notes. If not identical, a bearing and distance must be given from each established corner of the survey to the corresponding corner of the location, and the location corner must be fully described, so that it can be identified. The lines of the location, as found upon the ground, must be laid down upon the preliminary plat in such a manner as to contrast and show the relation to the lines of survey. (1 L. D., 581.)

The survey will be given but one number. A location under the mining laws can legally be made only of a tract or piece of land embraced within one set of boundary lines; and two or more tracts merely cornering with each other cannot legally be embraced in a single location. (33 L. D., 560; 35 L. D., 485.)

11. In accordance with the principle that courses and distances must give way when in conflict with fixed objects and monuments, you will not under any circumstances change the corners of the location for the purpose of making them conform to the description in the record. If the difference from the location be slight, it may be explained in the field notes.

The act of Congress of May 10, 1872, expressly provides that "the location must be distinctly marked upon the ground so that its boundaries can be readily traced," and "that all records of mining claims hereafter made *shall contain* the name or names of the locators, the date of the location, *such a description* of the claim or claims located, by reference to some

natural object or permanent monument, as will identify the claim." (Sec. 2324, U. S. Rev. Stats.)

These provisions of the law must be strictly complied with in each case to entitle the claimant to a survey and patent, and, therefore, should a claimant under a location made subsequent to the passage of the act of May 10, 1872, who has not complied with said requirements in regard to marking the location upon the ground and recording the same, apply for a survey, you will decline to make it. (1 L. D., 582.) You will then report the facts to the surveyor general and await further instructions.

Should the survey be applied for under a location made prior to May 10, 1872, under section 2332, United States Revised Statutes, in making the survey thereof you will be governed by the special instructions accompanying the order for survey.

No mining claim located subsequent to May 10, 1872, should exceed the statutory limit in width on each side of the center of vein, or 1,500 feet in length, and all surveys must close within 50/100 feet in 1,000 feet, and the error must not be such as to make the location exceed the statutory limit; and in absence of other proof the discovery point is held to be the center of the vein on the surface. The course and length of the vein should be marked upon the plat and specifically described in the field notes.

Lode Line and End Lines

It was held (syllabus) in 35 L. D., 22, that —

" There is no warrant in the mining laws for extending, arbitrarily and without any basis of fact therefor, the vein or lode line of a location in an irregular and zigzag manner for the purpose of controlling the length or situation of the exterior lines of the location to suit the convenience, real or imagined, of the locator.

"The end lines of a lode location must be straight and parallel to each other and when at right angles with the side lines may not exceed 600 feet in length.

"The mining laws contemplate that the end lines of a lode claim shall have substantial existence in fact, and in length shall reasonably comport with the width of the claim as located."

Instrument

12. All mineral surveys must be made with a transit, either with or without solar attachment, by which the meridian can be determined independently of the magnetic needle, and all courses must be referred to the true meridian. The variation should be noted at each corner of the survey.

The True Meridian

13. The true course of at least one line of each survey must be ascertained by astronomical observations, i.e., either Polaris or sun observations, made at the time of the survey; the data for determining the same and details as to how these data were arrived at must be given. Or, in lieu of the foregoing, the survey must be connected with some line the true course of which has been previously established beyond question, and in a similar manner by yourself, and, when such lines exist, it is desirable in all cases that they should be used as a proof of the accuracy of subsequent work. In this connection you will be governed by the instructions for methods of obtaining a true meridian.

Connections

14. Connect corner No. 1 of each location embraced in your survey by course and distance with nearest corner of the public survey or with a United States mineral monument if the claim lies within 2 miles of such corner or monument. If both are within the required distance, you must connect with the nearest corner of the public survey. (7 L. D., 475; paragraph 46, Mining Circular, May 21, 1907.)

(a) You will make surveys and connection of mineral claims in suspended townships, so long as they remain suspended, in the same manner as though the claims were upon unsurveyed land, except as hereinbefore specified, by connecting them with independent mineral monuments. At the same time you will note the position of any public land corner which may be found in the neighborhood of the claim, so that, in case of the release of the township plat from suspension, the position of the claim can be shown on the plat.

(b) A mineral survey must not be returned with its connection made only with a corner of the public survey, where the survey of the township within which it is situated is under suspension, nor connected with a mineral monument alone when situated within the limits of a township or within 2 miles of a corner thereof, the regularity and correctness of the survey of which is unquestioned.

If a mining claim is situated within the limits of a township, the regularity and correctness of the survey of which is unquestioned, but no corner of the public survey can be found within 2 miles of the claim after diligent search, connection may be made with a mineral monument, the mineral monument to be connected with a regularly established survey corner.

(c) In making an official survey hereafter you will establish corner *No. 1* of each location embraced in your survey at the corner nearest the corner of the public survey or mineral monument, unless good cause is

shown for its being placed otherwise. If connections are given to both a corner of the public survey and mineral monument, corner No. 1 should be placed at the end nearest the corner of the public survey.

15. When a boundary line of a mineral claim intersects a section line, give courses and distances from the points of intersection to the corners of the public surveys at each end of the half mile of section line so intersected.

Mineral Monuments

16. In case your survey is situated in a district where there are no corners of the public survey and no monuments within the prescribed limits, you will proceed to establish a mineral monument, in the location of which you will exercise the greatest care to insure permanency as to site and construction.

The site, when practicable, should be some prominent point, visible for a long distance from every direction, and should be so chosen that the permanency of the monument will not be endangered by snow, rock or landslides, or other natural causes. Its position with reference to latitude and longitude should be determined and stated as accurately as the instruments used will permit.

17. The monument should consist of a stone not less than 30 inches long, 20 inches wide, and 6 inches thick, set half way in the ground, with a conical mound of stone 4 feet high and 6 feet base alongside. The letters U. S. M. M., followed by the consecutive number of the monument in the district, must be plainly chiseled upon the stone. If impracticable to obtain a stone of required dimensions, then a post 8 feet long, 6 inches square, set 3 feet in the ground, scribed as for a stone monument, protected by a well-built conical mound of stone of not less than 3 feet high and 6 feet base around it, may be used. The exact point for connection must be indicated on the monument by a + chiseled thereon; if a post is used, then a tack must be driven into the post to indicate the point. Any necessary departure from the prescribed material and size of monument must be fully explained.

18. From the monument, connections by course and distance must be taken to two or three bearing trees or rocks, and to any well-known and permanent objects in the vicinity, such as the confluence of streams, prominent rocks, buildings, shafts, or mouths of adits. Bearing trees must be properly scribed *BT* and bearing rocks chiseled *BR* together with the number of the mineral monument; the exact point on the tree or stone to which the connection is taken should be indicated by a cross or other unmistakable mark. Bearings should also be taken to prominent mountain peaks, and the approximate distance and direction ascertained from the nearest town or mining camp. A detailed description of the mineral

monument, with a topographical map of its location, should be furnished the General Land Office.

Where practicable, it is desired that mineral surveyors connect by course and distance with mineral monuments in the vicinity other than those prescribed for connections as being within the limitation of distance. The purpose of this is to enable the General Land Office to locate the various mineral monuments established and used prior to the extension of the public subdivisional surveys over the land.

Corners

19. Corners may consist of —

(1) A stone at least 24 inches long set 12 inches in the ground, with a conical mound of stone 1½ feet high, 2 feet base alongside, and state kind of stone set for corner. A stone should always be used for a corner when possible.

(2) A post at least 3 feet long by 4 inches square, set 18 inches in the ground and surrounded by a substantial mound of stone or earth.

(3) A rock in place.

Should it become necessary to vary from these instructions, your returns must contain a full statement of the reason for establishing a corner differing from those prescribed.

20. All corners must be established in a permanent and workmanlike manner, and the corner and survey number must be neatly chiseled or scribed on the sides facing the claim. The **exact** corner point must be permanently indicated on the corner. When a rock in place is used its dimensions above ground must be stated, and a cross chiseled at the exact corner point.

21. In case the point for the corner be inaccessible or unsuitable, you will establish a witness corner, which must be marked with the letters *WC* in addition to the corner and survey number. The witness corner should be located upon a line of the survey and as near as possible to the true corner with which it must be connected by course and distance. The reason why it is impossible or impracticable to establish the true corner must always be stated in the field notes, and in running your next course state whether you start from the true place for corner or from witness corner.

22. The identity of all corners should be perpetuated by taking the courses and distances to bearing trees, rocks, and other objects, as prescribed in the establishment of mineral monuments, and when no bearings are given, state "no bearings available." Permanent objects should be *selected* for bearings whenever possible.

23. If an official mineral survey has been made in the vicinity, within

a reasonable distance, a further connecting line should be run to some corner thereof; and in like manner all conflicting surveys and locations should be so connected, and the corner with which connection is made in each case described. Such connections will be made and conflicts shown according to the boundaries of the neighboring or conflicting claims as each is marked, defined, and actually established upon the ground. You will fully and specifically state in your returns **how** and by what **visible evidences** you were able to identify on the ground the several conflicting surveys and those which appear according to their returned tie or boundary lines to conflict, if they were so identified, and report errors or discrepancies found by you in any such surveys. In the survey of contiguous claims which constitute a consolidated group, where corne· are common, bearings should be mentioned but once.

Tubular iron posts with flaring base, cement core, and brass cap for marking with steel stamps, have been adopted for agricultural public-land-survey corners, and it is believed that, wherever possible, the establishment of similar corners for mineral surveys would add greatly to the value of the survey made. Such corners are identified at a glance, may be accurately set, are difficult to move, easily found, and are indestructible. Their use is recommended.

Topography

24. Note carefully all topographical features of the claim, taking distances on your lines to intersections with all streams, gulches, ditches, ravines, mountain ridges, roads, trails, etc., with their widths, courses, and other data that may be required to map them correctly. If the claim lies within a townsite, locate all municipal improvements, such as blocks, streets and buildings.

Conflicts

25. If, in running the exterior lines of a claim, the survey is found to conflict with the survey of another claim, the distances to the points of intersection, and the courses and distances along the line intersected from an established corner of such conflicting claim to such points of intersection, should be described in the field notes: **Provided,** That where a corner of the conflicting survey falls within the claim being surveyed, such corner should be selected from which to give the bearing, otherwise the corner nearest the intersection should be taken. The same rule should govern in the survey of claims embracing two or more locations the lines of which intersect.

Lode and Mill Site

26. A lode and mill-site claim in one survey will be distinguished by the letters *A* and *B* following the number of the survey. The corners of the mill site will be numbered independently of those of the lode. Corner No. 1 of the mill site must be connected with a corner of the lode claim as well as with a corner of the public survey or mineral monument.

Field Notes

27. In order that the results of your survey may be reported in a uniform manner, you will prepare your field notes and preliminary plat in strict conformity with the specimen field notes and plats, which are made part of these instructions. They are designed to furnish you all the needed information concerning the manner of describing the boundaries, corners, connections, intersections, conflicts, and improvements, and stating the variation, area, location, and other data connected with the survey of mineral claims, and certain forms of affidavits for the surveyor and his assistants.

28. When a placer claim includes lodes, or when several contiguous placer or lode locations are included as one claim in one survey, you will give to the corners of each location constituting the same a separate consecutive numerical designation, beginning with corner No. 1 in each case. In the former case, you will first describe the placer claim in your field notes.

29. Throughout the description of the survey, after each reference to the lines or corners of a location, give the name thereof, and if unsurveyed state the fact. If reference is made to a location included in a prior official survey, the survey number must be given, followed by the name of the location. Describe your corners once only.

30. The total area of each location in a group embraced by its exterior boundaries, and also the area in conflict with each intersecting survey or claim, should be stated. The area claimed will not be stated. But when locations of the survey conflict with each other such conflicts should only be stated in connection with the location from which the conflicting area is excluded.

The field notes and plat of survey should not show **exclusions**, or attempt to specify the **net area** of the claim. These are matters for the applicant to state in connection with his application for patent, and the notices posted and published. The field notes should merely show the total and net areas of conflict, so that any exclusion desired may be readily made.

31. You will state particularly whether the claim is upon surveyed or unsurveyed public lands, giving in the former case the quarter section,

township, and range in which it is located, and in the latter, the township and range as near as can be determined. When upon surveyed lands the section lines should be indicated by full lines and the quarter-section lines by dotted lines.

32. The title page must contain the post office address of the claimant or his authorized agent.

Expenditure of $500

33. In making out your certificate of the value of the improvements, you will follow the form prescribed in the specimen field notes.

34. Only **actual** expenditures and **mining** improvements made by the claimant or his grantors, having a direct relation to the development of the claim, can be included in your estimate. "Labor or improvements, within the meaning of the statute, are deemed to have been had on a mining claim, whether it consists of one location or several, when the labor is performed or the improvements are made for its development, that is, to facilitate the extraction of the metals it may contain." (6 L. D., 222.)

35. The expenditures required may be made from the surface or in running a tunnel, drifts, or crosscuts, for the development of the claim. Improvements of any other character, such as buildings, machinery, or roadways, must be excluded from your estimate unless you show clearly that they are associated with actual excavations, such as cuts, tunnels, shafts, etc., are essential to the practical development of, and actually facilitate the extraction of mineral from the claim.

36. You will locate all mining and other improvements upon the claim by courses and distances from corners of the survey, or from points on the indicated lode line, or side lines, specifying with particularity and detail the dimensions and character of each, and the improvements upon each location should be numbered consecutively, the point of discovery being always No. 1. Improvements made by a former locator, who has abandoned his claim, cannot be included in the estimate, but should be described and located by separate statement, in the notes and on the plat.

37. You will give in detail the **value** of each mining improvement included in your estimate of expenditures, and when a tunnel or other improvement has been made for the development of other claims in connection with the one for which survey is made, you must give the name, ownership, and survey number, if any, of each claim to be credited, and the value of the interest credited to each claim.

38. In case of a lode and mill site in the same survey, an expenditure of $500 is required to be shown upon the lode claim only.

Common Improvements, Etc.

39. When a survey embraces several locations held in common constituting one entire claim, whether lode or placer, an expenditure of $500 for each location embraced in the survey will be sufficient.

It was held (syllabus) in 35 L. D., 361, that —

"Where several contiguous mining claims are held in common and expenditures are made upon an improvement intended to aid in the common development of all of the claims so held, and which is of such character as to redound to the benefit of all, such improvement is properly called a common improvement.

"Each of a group of contiguous mining claims held in common and developed by a common improvement has an equal, undivided interest in such improvement, which is to be determined by a calculation based upon the number of claims in the group and the value of the common improvement.

"There is no authority in the law for an unequal assignment of credits out of the cost of an improvement made for the common benefit of a number of mining claims, or the apportionment of a physical segment of an improvement of that character to any particular claim or claims of the number, such an arbitrary judgment of credits, as the exigencies of the case may seem to require, being utterly at variance with the essential idea inherent in the term, a common improvement.

"In any patent proceedings where a part of a group of mining claims is applied for and reliance is had upon a common improvement, the land department should be fully advised as to the total number of claims embraced in the group, as to their ownership, and as to their relative situations, properly delineated upon an authenticated map or diagram. Such information should always be furnished in connection with the first proceeding involving an application of credit from the common improvement, and should be referred to and properly supplemented in each subsequent patent application in which a like credit is sought to be applied."

Improvements Succeed Locations, Etc.

It was held (syllabus) in 36 L. D., 551, that —

"A common improvement or system, offered for patent purposes, although of sufficient aggregate value and of the requisite benefit to all the mining claims of a group, cannot be accepted as it then stands in full satisfaction of the statutory requirement as to such of the claims the location of which it preceded, the law requiring that an expenditure of at least $500 shall succeed the location of every claim.

"*If the requisite* benefit to the group is shown, or to the extent of such *e claims* as are so benefited, and the elements of contiguity and com-

mon interest in the claims concerned appear; if the improvement represents a total value sufficient for patent purposes for the number of claims so involved; if for each claim located after the partial construction of the improvement the latter has been subsequently extended so as to represent an added value of not less than $500, each is entitled under the law to a share of the value of the common improvement in its entirety, no claim receiving more or less than another from that source, participating therein without distinction or difference, and as to each the statutory requirement is satisfied."

40. The explanatory statement in such cases should be given in your field notes, or affidavit, at the conclusion of the description of the improvements included in the estimate of expenditure, and should be as full and explicit as the facts in the case warrant, dealing only with the improvements, conditions, and circumstances as they actually existed at the time of making the survey or examination.

41. If the value of the labor and improvements upon a mineral claim is less than $500 at the time of survey, you are authorized to file thereafter supplemental proof, showing $500 expenditure made prior to the expiration of the period of publication. The information on which to base this proof must be derived by the surveyor, who makes the actual survey, from a careful examination upon the premises.

42. You will file with your field notes a preliminary plat made on tracing cloth, protracted on a scale of 200 feet to an inch, if practicable, in conformity with the specimen plat herewith. In preparing plats make the top north. Copy of your calculations of areas by double meridian distances and of all triangulations or traverse lines must also be furnished. The lines of the claim surveyed, on this plat and on all plats of approved surveys, should be heavier and show a contrast with conflicting claims.

Errors

43. Where error in an original survey appears prior to the issuance of patent, the surveyor, who made such survey, will be required to make the necessary corrections in the field within a specified time; and failure or refusal, without satisfactory reason therefor, to comply with instructions will be followed by suspension or revocation of appointment. The mineral claimant will be notified of the action taken and given a reasonable time to apply for an amended survey.

Whenever a survey is reported in error by a surveyor, the surveyor who made the survey will be required promptly to examine same upon the ground, and, if found in error, will report the errors in detail, under oath to the surveyor general's office. If he should report his survey corr

plied, unless with the surveyor who requested the survey will be entered in order that deficiencies

Joint Survey

44. A joint survey must be made within two days after the time of meeting unless additional days necessary are stipulated, under oath, for a postponement.

45. The field notes of every survey of the same be a joint and not a separate survey, and the observations and measurements taken with the same instruments and chains, carefully tested and agreed upon.

46. The surveyor in charge will make out the field notes of the joint survey, which, after being duly signed and sworn to by both parties, must be transmitted to the surveyor general's office.

Amended Surveys

47. Instructions to amended surveys are ordered only by special instructions from the General Land Office, and the conditions and circumstances governing in each separate case, and the object sought by the required amendment, always governs all special matters relative to the manner of making such survey and the form and subject-matter to be embraced in the field notes thereof, but few general rules applicable to all cases can be laid down.

48. The amended survey must be made in strict conformity with, or be confined within, the lines of the original survey. If the amended and original surveys are identical, that fact must be clearly and distinctly stated in your field notes. If not identical, a bearing and distance must be given from each established corner of the amended survey to the corresponding corner of the original survey. The lines of the original survey, as found upon the ground, must be laid down upon the preliminary plat in such manner as to contrast and show their relation to the lines of the amended survey.

49. The field notes of the amended survey must be prepared on the same size and form of blanks as are the field notes of the original survey, and the word "amended" must be used before the word "survey" wherever it occurs in the field notes.

Descriptive Reports on Placer Claims

50. By General Land Office circular, approved May 21, 1907, paragraph 60, you are required to make a full examination of all placer claims at the time of survey, and file with your field notes a descriptive report, in which you will describe:

(a) The quality and composition of the soil, and the kind and amount ber, and other vegetation.

(*b*) The location and size of streams, and such other matter as may appear upon the surface of the claims.

(*c*) The character and extent of all surface and underground workings, whether placer or lode, for mining purposes, locating and describing them.

(*d*) The proximity of centers of trade or residence.

(*e*) The proximity of well-known systems of lode deposits or of individual lodes.

(*f*) The use or adaptability of the claim for placer mining, and whether water has been brought upon it in sufficient quantity to mine the same, or whether it can be procured for that purpose.

(*g*) What works or expenditures have been made by the claimant or his grantors for the development of the claim, and their situation and location with respect to the same as applied for.

(*h*) The true situation of all mines, salt licks, salt springs, and mill seats, which come to your knowledge, or report that none exist on the claim, as the facts may warrant.

(*i*) Said report must be made under oath, and duly corroborated by one or more disinterested persons.

51. Descriptive reports, as above, on placer claims taken by legal subdivisions will not be made, as mineral surveyors have no duties to perform touching such claims. (Sec. 2331, U. S. Rev. Stats., and paragraph 58, Mining Circular, approved May 21, 1907.)

Practice

52. Claimants, their attorneys, or parties in interest shall not be employed as assistants in making mineral surveys.

53. Your field work must be accurately and properly performed and your returns made in conformity with the foregoing instructions. Errors in the survey must be corrected at your own expense, and if the time required in the examination of your returns is increased by reason of your neglect or carelessness, you will be required to make an additional deposit for office work. You will be held to a strict accountability for the faithful discharge of your duties, and you will be required to observe fully the requirements and regulations in force as to making mineral surveys. If found incompetent as a surveyor, careless in the discharge of your duties, or guilty of a violation of said regulations, your appointment will be promptly revoked.

A mineral surveyor is within the purview of section 452 of the Revised Statutes, which prohibits officers, clerks, and employees in the General Land Office from directly or indirectly purchasing or becoming interested in the purchase of any of the public lands, upon penalty of forfeiture of his official position. (36 L. D., 61.)

Circular to Applicants

Applicants for mineral survey orders will observe the following requirements in the conduct of their business with the surveyor general's office, the same being based upon the United States mining laws, and circular and special instructions from the Commissioner of the General Land Office:

1. **All applications for survey orders, descriptive reports on placer claims, or certificates of $500 expenditures, should be addressed to the surveyor general, and be signed by the claimants, their agents or attorney.**

2. **Each application should contain:**

(*a*) **The name of the claimant in full, and as it is desired to appear in the application for patent.**

(*b*) **The name of each location embraced in the claim.**

(*c*) **The name of the land and mining districts in which the claim is located.**

(*d*) **The name of the mineral surveyor to whom it is desired the order shall be issued.**

(For form of application see page 148.)

3. The applicant is required to file with each application for survey order a copy of the record of location of the claim, properly certified by the recorder of the county or mining district where the claim is situate.

4. The mineral surveyor is required to survey the claim in **strict conformity** with or **within** the lines of the location upon which the order of survey is based. The applicant is therefore advised, before filing his application, to see that his location has been made in compliance with the law and regulations, and that it properly describes the claim for which patent is to be sought.

Section 2324, United States Revised Statutes, expressly provides that "the location must be distinctly marked on the ground so that its boundaries can be readily traced," and that "all records of mining claims hereafter made shall contain the name or names of the locators, the date of the location, and such a description of the claim or claims located by reference to some natural object or permanent monument as will identify the claim."

These provisions of the law must be strictly complied with in each case, to entitle a claimant to a survey and patent, and therefore should a claimant under a location made **subsequent** to the passage of the mining act of May 10, 1872 (referred to in said section 2324), who has not complied with such requirements in regard to marking the location upon the ground, and recording the same, apply for a survey, the surveyor general will decline to order it.

The only relief for a party under such circumstances will be to make a

new location in conformity to law and regulations, as no survey will be approved by the surveyor general's office, unless these and all other provisions of law are substantially complied with.

A lode locator may not, in the same location, lawfully include any surface area, or acquire any incidental mining rights therein, outside of the course of, or vertical planes drawn downward through, the established end lines of his claim extended in their own direction. (35 L. D., 592.)

5. The surveyor general will furnish the applicant an estimate of the cost of the **platting** and other **office work** connected with the survey in his office, which amount the applicant will deposit with any assistant United States treasurer, or designated depository, in favor of the United States Treasurer, to be passed to the credit of the fund created by "individual depositors for surveys of the public lands." The duplicate certificate issued for such deposit will be immediately forwarded to the office of the surveyor general by the applicant, who will retain the triplicate certificate for his own use and security. Under no circumstances can this deposit be made with or by the surveyor general.

Payment for **exemplified copies** of plats or other records in the office of the surveyor general will be made or remitted directly to that officer, who will promptly receipt for the same. (36 L. D., 125.)

6. The various surveyors general have schedules of rates for office work, and an estimate of the cost in any particular case may be had upon application.

Should an applicant deem an estimate excessive, he will be allowed the right of appeal to the General Land Office in the usual manner.

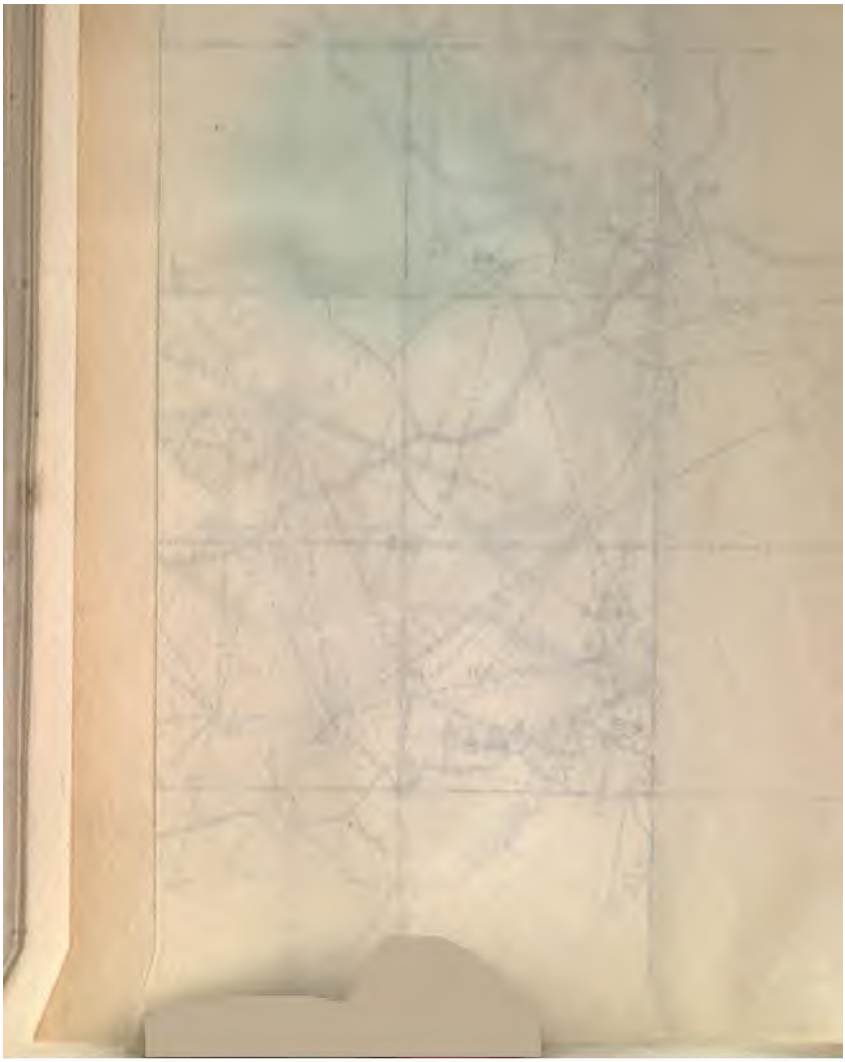
In transmitting such an appeal the surveyor general should transmit therewith a full report.

7. An application for an amended survey order must be accompanied with a statement setting forth fully the reasons for the proposed amendment and all the material facts in the matter.

8. If, after having obtained a survey order, the applicant should abandon his purpose of having a survey made, he can apply the deposit, less the amount estimated for office expenses already incurred, on a survey of **another claim** if one is desired.

9. Upon discovery of any error or defect in an order the applicant is requested to return it to the surveyor general's office for correction or amendment.

10. If, after having obtained an order for survey, the applicant should find that the record of location does not practically describe the location as staked upon the ground, he should file a certified copy of an amended location certificate, correctly describing the claim, and obtain an **amended order** for survey.



13. The applicant is advised of his right to appeal to the Commissioner of the General Land Office from the approval or disapproval of the survey of his claim. The appeal must be in writing or in print, should set forth in brief and clear terms the specific points of exception to the ruling appealed from, and should be transmitted through the surveyor general's office.

INDEX

Adverses, 143, 173
Altitude tables, 19
Angles
  from courses, 109
  reading vertical angles, 59
Area Statements, 136, 138, 153, 160
Azimuth,
  courses from angles, 62
  errors in azimuth, 16
  tables, 19

Circular on patenting, 204
Courses from angles, 62

Davis Screen, 2
Declination, 15, 31, 38

Ephemeris, 31
Errors,
  in azimuth, 16
  patented surveys, 139
Examination for Commission,
  California, 202
  general figuring, 196
  lode line, 193
  Oregon, 203
  placer calculations, 187
  South Dakota, 197
  subdivision of section, 196
Examples,
  angles from courses, 109
  angular claims end lines, 71
  closing angular claims, 75
  courses from angles, 62
  double meridian distances, 87, 135, 188
  figuring horizontal distances, 59
  Hosmer's solar formula, 20
  latitude, 24
  latitudes and departures, 64
  latitude Shattuck solar, 32
  lode line, 193
  McElroy's solar formula, 19
  mill sites, 84, 85, 86

Examples,
  missing course, 64
  atent figuring, 111-137
  placer calculations, 187
  reduction stadia measurements, 55, 56
  slope measurements from horizontal, 60
  solar sine formula, 21
  subdivisions of sections, 195
  to check oblique triangle, 117

Forms,
  adverses, 143
  amended location certificate, 79
  application for survey, 145, 148
  corroborative affidavit, 163
  descriptive report on placer, 161
  estimates of costs, 146
  lode location certificates, 68, 72, 157
  mill site location certificate, 88, 158
  net area statement, 160
  oaths of assistants, 155
  oaths mineral surveyor, 156, 163
  order for mineral survey, 146, 148
  placer location certificate, 80, 161
  re-location certificate, 81
  Specimen field notes, 149-160
  Surveyor General's approval, 159
  Surveyor General's final certificate, 159
  tunnel site location certificate, 91
Formulas,
  derivation solar formula, 4
  errors in azimuth, 16, 17
  Hosmer's solar, 20
  McElroy's solar, 6
  solar sine, 21
  time, 22

Land Office Regulations,
  adverse claims, 173

Land Office Regulations,
mill sites, 171
mineral claims, 164
mineral surveyors, 176
patent survey procedure, 166
placer claims, 169
Section 2334, 165
Surveyor General, 173
Latitude,
observations, 22
Burt solar, 45
Shattuck solar, 30
Legal Subdivisions,
general rules, 93
subdivisions of sections, 94
Location certificates,
amended, 79
angular claims, 72, 158
mill site, 88, 158
placer, 89, 161
re-location, 81
straight claim, 68, 157
tunnel site, 90
Location surveys,
angular claims, 70
end lines, 77, 78
lode locations, 65
mill sites, 82
note book page, 66
placers, 82, 92
tunnel sites, 90
variations straight claim, 70

Manual of Instructions,
amended surveys, 228
appointment mineral surveyor, 214
bonds, 215
circular to applicants, 230
conflicts, 223
connections, 220
corners, 222
descriptive reports placers, 228
end lines, 219
errors, 227
expenditures, 225
field notes, 224
field work, 217
improvements, 226
instructions, 216
instrument, 219
joint survey, 228
lode and end lines, 219
le and mill site, 224

Manual of Instructions,
mineral monuments, 221
practice, 229
survey and locations, 218
topography, 223
true meridian, 220
Measurements,
stadia, 55
tape, 53
Meridian,
direct solar observation, 1
by Shattuck solar, 27
placing the sun, 2
Missing course, 64

Note book page, 66, 113
blank form, 184

Observations,
direct solar, 1
latitude, 22
Burt solar, 45
Shattuck solar, 30
meridian Shattuck solar, 27
placing the sun, 2
Office records, 180, 182, 184
Offsets, 61

Patent figuring, 111–137
note book page, 113
Patent surveys,
cancellation of claim, 142
claim groups, 108
connections, 106, 108
excluding discoveries, 138
expenditure of $500, 141
joint surveys, 139
mill site for mining purposes, 142
mutual benefit, 141
patented positions, 139
reporting errors, 139
shortening claims, 140
supplementary affidavit of labor, 142
tracts, 137
triangulation systems, 107

Solar attachments,
adjustments Burt solar, 46
Berger solar, 49
Burt solar, 33
latitude Burt solar, 45
latitude Shattuck solar, 30
meridian, Shattuck solar, 27

Solar attachments,
Saegmuller solar, 49
Shattuck solar, 25
vein tracing, 102
Specimen Field Notes, 145
Stadia,
measurements, 55
reductions, 55
reduction tables, 57
Stations, 58
Surveying for patent, 104

Tables,
altitudes and azimuths, 19
area in feet or acres, 83
correction semi diameter, 14
declination solar attachments, 39
Tables,
errors in azimuth, 16, 17
mean refraction, 15
outcrop, dip-strike, 101
stadia angles to traverse tables, 57
Standard Field Tables, 59
traverse tables, 59, 63
Tapes, 54
Tape menders, 54
Traversing, 52
Traverse tables, 57, 59, 63
Triangulation systems, 107

Vein tracing,
solar attachment, 102
transit, 98

OCT 24 1941